

# PHYSICS & ASTRONOMY (PHY)

## PHY093. Physics Special Topics. 0 Credits.

May be repeated for credit

## PHY108. Seeing the Light: Physics, Vision and Art. 3 Credits.

A study of light, vision and art from an optical physics perspective, learning about photons, wavelength, and energy how our eyes see light, and the creation of visual art. Learn the function of the eye's lens, retina and visual cortex, and explore parallel developments in art, vision and physics.

### Attributes:

- Liberal Arts
- GE4: Natural Science Course
- GE5: Natural Science Course
- GE3: NSCI
- Systematic Inquiry

### Restrictions:

- Must have the following level: Undergraduate
- Must not be enrolled in the following field(s) of study (major, minor or concentration): Comm Disorders Post-BA (089)

### Prerequisites:

- Math Placement Level Minimum Score of 3 or MAT053 Minimum Grade of C- or MAT120 Minimum Grade of C- or MAT121 Minimum Grade of C-

May not be repeated for credit

## PHY109. Physics of Sound and Music. 3 Credits.

Nature, transmission, and absorption of sound; speech; hearing; music; noise; musical instruments and amplifying systems; rooms and auditoriums; sources of noise and noise pollution; noise codes; control of noise; and practical means of noise reduction.

### Attributes:

- Liberal Arts
- GE4: Natural Science Course
- GE5: Natural Science Course
- GE3: NSCI

### Restrictions:

- Must have the following level: Undergraduate
- Must not be enrolled in the following field(s) of study (major, minor or concentration): Physics (511)

### Prerequisites:

- Math Placement Level Minimum Score of 3 or MAT053 Minimum Grade of C- or MAT120 Minimum Grade of C- or MAT121 Minimum Grade of C-

May not be repeated for credit

## PHY193. Physics Selected Topic. 1-12 Credits.

Selected topics courses are regularly scheduled courses that focus on a particular topic of interest. Descriptions are printed in the Schedule of Classes each semester. Selected topics courses may be used as elective credit and may be repeated for credit, provided that the topic of the course changes.

May be repeated for credit

## PHY199. Modular Course. 0 Credits.

May not be repeated for credit

## PHY201. General Physics 1. 3 Credits.

Basic principles of mechanics, wave motion, and thermodynamics using vector analysis and calculus. Primarily for students majoring in physics, engineering, mathematics, and chemistry; students majoring in biology and geology should consult their advisor if they wish to take this course in preference to PHY221.

### Attributes:

- Liberal Arts
- GE4: Natural Science Lecture
- GE5: Natural Science Lecture
- GE3: NSCI
- Systematic Inquiry

### Restrictions:

- Must have the following level: Undergraduate
- Must not be enrolled in the following field(s) of study (major, minor or concentration): Comm Disorders Post-BA (089)

### Prerequisites:

- Math Placement Level Minimum Score of 6 or MAT251 Minimum Grade of C-

### Corequisites:

- PHY211

May not be repeated for credit

## PHY202. General Physics 2. 3 Credits.

Basic principles of electricity, magnetism, and optics using vector analysis and calculus. Primarily for students majoring in physics, engineering, mathematics, and chemistry; students majoring in biology and geology should consult their advisor if they wish to take this course in preference to PHY222.

### Attributes:

- Liberal Arts
- GE4: Natural Science Lecture
- GE3: NSCI
- Systematic Inquiry

### Restrictions:

- Must have the following level: Undergraduate

### Prerequisites:

- PHY201 Minimum Grade of D-
- MAT252 Minimum Grade of C-

### Corequisites:

- PHY212

May not be repeated for credit

**PHY203. General Physics I Workshop. 0 Credits.**

Problem-solving course to be taken concurrently with PHY201 gives students an opportunity to solve additional problems, preview sample exams or review exams, and ask questions about lecture material.

**Restrictions:**

- Must have the following level: Undergraduate

**Corequisites:**

- PHY201

May not be repeated for credit

**PHY204. General Physics II Workshop. 0 Credits.**

Problem-solving course to be taken concurrently with PHY202 gives students an opportunity to solve additional problems, preview sample exams or review exams, and ask questions about lecture materials.

**Restrictions:**

- Must have the following level: Undergraduate

**Corequisites:**

- PHY202

May not be repeated for credit

**PHY205. Exploring the Solar System. 3 Credits.**

Introduction to solar system including history of astronomy, laws of mechanics and gravitation, motions of heavenly bodies, telescopes, space exploration and descriptions of sun, planets, moons, asteroids, comets and meteors. Planetarium demonstrations, sky viewing with telescopes and computer simulations. No science preparation required. Limited use of algebra. No prerequisite.

**Attributes:**

- Liberal Arts
- GE4: Natural Science Lecture
- GE4: Natural Science Course
- GE5: Natural Science Lecture
- GE5: Natural Science Course
- GE3: NSCI
- Systematic Inquiry

**Restrictions:**

- Must have the following level: Undergraduate

May not be repeated for credit

**PHY206. Exploring the Universe. 3 Credits.**

Introduction to the universe beyond the solar system. Distance to stars, classes of stars, structure of stars, stellar evolution, white dwarfs, neutron stars, black holes, pulsars, quasars, radio astronomy, the Milky Way, galaxies, relativity and cosmology. Planetarium demonstrations, sky viewing with telescopes and computer simulation. No science preparation required. Limited use of Algebra.

**Attributes:**

- Liberal Arts
- GE4: Natural Science Course
- GE5: Natural Science Course
- GE3: NSCI
- Systematic Inquiry

**Restrictions:**

- Must have the following level: Undergraduate

May not be repeated for credit

**PHY207. Exploring Astronomy Laboratory. 1 Credit.**

Application of astronomy principles through observing the night sky and modeling astronomical phenomena in a lab setting. Students will use and construct simple telescopes and other tools to take astronomical measurements and interpret results. Computer simulations and other models will be used to demonstrate sky and planetary motion.

**Attributes:**

- Liberal Arts
- GE4: Natural Science Lab
- GE5: Natural Science Lab

**Restrictions:**

- Must have the following level: Undergraduate

**Prerequisites:**

- PHY205 Minimum Grade of D-\*
- Math Placement Level Minimum Score of 4 or MAT152 Minimum Grade of C-

\* May be taken at the same time

May not be repeated for credit

**PHY208. The World of Sound. 4 Credits.**

Fundamentals of acoustics, acoustical measurement and analysis, acoustics technology, and digital processing of acoustical signals. This course includes a laboratory component.

**Attributes:**

- Liberal Arts
- GE4: Natural Science Lecture
- GE4: Natural Science Lab
- GE5: Natural Science Lecture
- GE5: Natural Science Lab
- GE3: NSCI
- Systematic Inquiry

**Restrictions:**

- Must have the following level: Undergraduate

**Prerequisites:**

- Math Placement Level Minimum Score of 3 or MAT 151 Minimum Grade of C- or MAT053 Minimum Grade of C- or MAT120 Minimum Grade of C- or MAT121 Minimum Grade of C-

May not be repeated for credit

**PHY211. Physics 1 Laboratory. 1 Credit.**

Experiments involve measurement and analysis using equipment such as air tracks, motion sensors, force meters, and photogate timers, coupled with computer software, to gain insight into linear and rotational motion phenomena.

**Attributes:**

- Practicum - Non-Clinical
- Critical Thinking Introductory
- Critical Think Reason Intro
- Information Literacy Intro
- Information Mgmt Intro
- Liberal Arts
- GE4: Natural Science Lab
- GE5: Natural Science Lab

**Prerequisites:**

- (PHY201 Minimum Grade of D-\*) or (PHY221 Minimum Grade of D-\*)

\* May be taken at the same time

May not be repeated for credit

**PHY212. General Physics 2 Lab. 1 Credit.****Attributes:**

- Practicum - Non-Clinical
- Liberal Arts
- GE4: Natural Science Lab

**Corequisites:**

- PHY202

May not be repeated for credit

**PHY221. Fundamental Physics 1. 3 Credits.**

An algebra-based introduction to particle mechanics, rigid-body and continuous matter motion, fluid mechanics, wave motion, structure of matter and thermo-dynamic principles.

**Attributes:**

- Liberal Arts
- GE4: Natural Science Lecture
- GE5: Natural Science Lecture
- GE3: NSCI
- Systematic Inquiry

**Restrictions:**

- Must have the following level: Undergraduate

**Prerequisites:**

- Math Placement Level Minimum Score of 4 or MAT193 Minimum Grade of C- or MAT152 Minimum Grade of C- or MAT 153 Minimum Grade of C-

**Corequisites:**

- PHY211

May not be repeated for credit

**PHY222. Fundamental Physics II. 3 Credits.**

An algebra-based introduction to electricity, magnetism, electromagnetic waves, optics, relativity, quanta, Bohr atom, complex atom, ions and molecules, solid state, nucleus, nuclear transformation, and elementary particles.

**Attributes:**

- Liberal Arts
- GE4: Natural Science Lecture
- GE3: NSCI
- Systematic Inquiry

**Restrictions:**

- Must have the following level: Undergraduate

**Prerequisites:**

- PHY221 Minimum Grade of D-

**Corequisites:**

- PHY232

May not be repeated for credit

**PHY223. Fundamental Physics I Workshop. 0 Credits.**

Problem-solving course to be taken concurrently with PHY221 gives students an opportunity to solve additional problems, preview sample exams or review exams, and ask questions about lecture material.

**Restrictions:**

- Must have the following level: Undergraduate

**Corequisites:**

- PHY221

May not be repeated for credit

**PHY224. Fundamental Physics II Workshop. 0 Credits.**

Problem-solving course to be taken concurrently with PHY222 gives students an opportunity to solve additional problems, preview sample exams or review exams, and ask questions about lecture material.

**Restrictions:**

- Must have the following level: Undergraduate

**Corequisites:**

- PHY222

May not be repeated for credit

**PHY231. Fundamental Physics 1 Lab. 1 Credit.****Attributes:**

- Practicum - Non-Clinical
- Liberal Arts
- GE4: Natural Science Lab
- GE5: Natural Science Lab

**Corequisites:**

- PHY221

May not be repeated for credit

**PHY232. Fundamental Physics 2 Lab. 1 Credit.****Attributes:**

- Practicum - Non-Clinical
- Liberal Arts
- GE4: Natural Science Lab

**Corequisites:**

- PHY222

May not be repeated for credit

**PHY293. Physics Selected Topic. 1-12 Credits.**

Selected topics courses are regularly scheduled courses that focus on a particular topic of interest. Descriptions are printed in the Schedule of Classes each semester. Selected topics courses may be used as elective credit and may be repeated for credit, provided that the topic of the course changes.

**Restrictions:**

- Must have the following level: Undergraduate

May be repeated for credit

**PHY295. Indep Study Physics. 1-12 Credits.****Restrictions:**

- Must have the following level: Undergraduate

May be repeated for credit

**PHY299. Modular Course. 0 Credits.****Restrictions:**

- Must have the following level: Undergraduate

May not be repeated for credit

**PHY300. Mathematical Physics I. 3 Credits.**

A study of the differential equations, linear algebra, and vector calculus in the context of the physical problems in which they arise. Computational techniques are used where appropriate.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- MAT252 Minimum Grade of C-

May not be repeated for credit

**PHY301. Mathematical Physics II. 3 Credits.**

A continuation of Mathematical Physics I. Fourier series, partial differential equations, and complex analysis, all discussed in the context of the physical problems in which they arise. Computer techniques are used where appropriate.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY300 Minimum Grade of D-

May not be repeated for credit

**PHY305. Computational Physics. 3 Credits.**

Introduction to numerical techniques – root finding, integration, matrix manipulations, differential equations. Numerical simulations – oscillations, space flight, electric fields, linear and non-linear waves, crystal growth.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY202 Minimum Grade of D-
- MAT341 Minimum Grade of C- or (MAT359 Minimum Grade of C- and MAT362 Minimum Grade of C-)

May not be repeated for credit

**PHY306. Mechanics 1. 3 Credits.**

This is the first of a two-semester sequence comprising a traditional classical mechanics course. Topics include one-dimensional motion, energy and momentum conservation, central forces, Lagrangian and Hamiltonian formulations, systems of particles, and accelerated coordinated systems.

**Attributes:**

- Critical Thinking Intermediate
- Critical Think Reason Intern
- Information Literacy Intermed
- Information Mgmt Intrmd
- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY202 Minimum Grade of D-
- MAT341 Minimum Grade of C-\* or MAT359 Minimum Grade of C-

\* May be taken at the same time

May not be repeated for credit

**PHY307. Mechanics 2. 3 Credits.**

This is the second of a two-semester sequence comprising a traditional classical mechanics course. Topics include Langrange and Hamiltonian formulations; gravitation, central force problems, and planetary motion; systems of particles; accelerated coordinate systems.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY306 Minimum Grade of D-
- MAT341 Minimum Grade of C- or MAT362 Minimum Grade of C-

May not be repeated for credit

**PHY308. Modern Physics I. 3 Credits.**

An introduction to the physics of atoms, starting with the origin of the quantum theory. Extensive discussion of the hydrogen atom. Other topics chosen from solid state physics, statistical physics, and nuclear physics if time permits. Computational techniques are used where appropriate.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY202 Minimum Grade of D-

May not be repeated for credit

**PHY309. Modern Physics II. 3 Credits.**

A continuation of Modern Physics I, covering special relativity and other topics chosen from atomic physics, nuclear physics, statistical physics, and solid state physics. Computational techniques are used where appropriate.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY308 Minimum Grade of D-

May not be repeated for credit

**PHY310. Modern Physics Laboratory. 1 Credit.**

A laboratory course demonstrating the principles of Modern Physics PHY309. Required for Physics majors.

**Attributes:**

- Practicum - Non-Clinical
- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY202 Minimum Grade of D-

May not be repeated for credit

**PHY311. Classical Mechanics. 3 Credits.**

An intermediate level course in Newtonian mechanics. Linear and angular motion, conservation laws, Lagrangian and Hamiltonian formulations. Computational methods are used where appropriate.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY300 Minimum Grade of D-

May not be repeated for credit

**PHY313. Electricity and Magnetism. 3 Credits.**

Laws of electricity and magnetism and their applications using vector analysis and computational techniques. Differential forms of Maxwell's equations.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY202 Minimum Grade of D-
- MAT353 Minimum Grade of C-
- MAT341 Minimum Grade of C- or (MAT359 Minimum Grade of C- and MAT362 Minimum Grade of C-)

May not be repeated for credit

**PHY314. Relativity. 1 Credit.**

This is a short course in Special Relativity covering the following aspects: experiments leading up to the theory, relative nature of time and distance measurements, constancy of the speed of light, Lorentz transformations, length contraction, time dilation, simultaneity, momentum and energy relations, mass-energy equivalence, and relativistic Doppler effect.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY202 Minimum Grade of D-

May not be repeated for credit

**PHY315. Engineering Mechanics. 4 Credits.**

A study of static and dynamic force systems. Vector and conventional techniques are used in problem solving. Properties of force systems, free body analysis, properties of area and mass, friction, kinematics and kinetics of particles and rigid bodies, energy and momentum method. Both English and SI units are used.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- MAT252 Minimum Grade of C-
- PHY201 Minimum Grade of D-

May not be repeated for credit

**PHY322. Optics. 3 Credits.**

Geometrical and physical optics including thick lenses, polarization, coherence, interference and diffraction; propagation in crystals; non-linear optics; photon statistics; radiation pressure; electro-optics; gas crystals; semi-conductor laser.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY308 Minimum Grade of D-
- MAT353 Minimum Grade of C-

May not be repeated for credit

**PHY323. Optics Laboratory. 2 Credits.**

Introduces students to advanced experiments in optical physics and to experimental techniques in physics research. Topics include lasers, reflection, lenses and imaging, and polarization. Emphasis is on students investigating each experiment and communicating their observations through reports and presentations to build essential research skills.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY308 Minimum Grade of D-

May not be repeated for credit

**PHY324. Optics Lab for Astronomers. 1 Credit.**

Introduces students to experiments in optical physics relevant to astronomy and to experimental techniques in physics and astronomy as a subset of Optics Lab for physics majors. Topics include reflection, lenses and imaging, and polarization. Emphasis is on students investigating and communicating their observations through notebooks and presentations to build essential skills.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman
- Must not be enrolled in the following field(s) of study (major, minor or concentration): Physics (511)

**Prerequisites:**

- PHY308 Minimum Grade of D-

May not be repeated for credit

**PHY331. Quantum Physics. 3 Credits.**

Origin of Planck's quantum hypothesis and its later development through the deBroglie wave-particle duality to the modern quantum mechanics of Schroedinger and Heisenberg. Principles of correspondence, complementarity, and uncertainty. Application of quantum mechanics to basic problems such as the time-independent Schroedinger Equ., hydrogen atom and spin phenomena.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY308 Minimum Grade of D-
- MAT341 Minimum Grade of C- or (MAT359 Minimum Grade of C- and MAT362 Minimum Grade of C-)

May not be repeated for credit

**PHY335. Thermal Physics. 3 Credits.**

Basic laws of thermodynamics. Conditions of equilibrium equations of state, Euler equation. Gibbs-Duhem relations, thermodynamic potentials, and the Nernst Theorem.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY202 Minimum Grade of D-
- CHE202 Minimum Grade of D-

May not be repeated for credit

**PHY340. Introduction to Astrophysics. 3 Credits.**

Introduction for science majors. Formation of stars, H-R diagram, binaries, brightness scale, distance ladder, doppler effect, stellar masses, parallax, proper motion, radial motion, mass-luminosity, black-body radiation, spectroscopy, telescopes, dense stars, black holes, galaxies, relativity and cosmology.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY201 Minimum Grade of D-

May not be repeated for credit



**PHY341. Observational Astronomy. 3 Credits.**

An introduction to the tools and techniques of observational astronomy, including astronomical image analysis, telescopes and CCD detectors, reduction and analysis of astronomical spectra. Course requires nighttime telescopic work.

**Attributes:**

- Practicum - Non-Clinical
- Critical Thinking Intermediate
- Information Mgmt Intrmd
- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY340 Minimum Grade of D- or PHY206 Minimum Grade of D-

May not be repeated for credit

**PHY342. Planetarium Operation. 3 Credits.**

Principles and operation of planetarium projection devices, and their use in developing public planetarium shows.

**Attributes:**

- Critical Think Reason Intern
- Information Literacy Intermed
- Information Mgmt Advanced
- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY205 Minimum Grade of D-

May not be repeated for credit

**PHY343. Solar Physics. 3 Credits.**

A study of the structure of the Sun, and the physical phenomena (such as sunquakes, eclipses, sunspots, flares, prominences) that take place in its interior and near the surface.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY340 Minimum Grade of D-

May not be repeated for credit

**PHY344. Life in the Universe. 3 Credits.**

Origin of life on Earth, possibility of life in the solar system, existence of other planetary systems, techniques for detection of and communication with other intelligences.

**Attributes:**

- Critical Thinking Advanced
- Critical Think Reasoning Adv
- Information Literacy Advanced
- Liberal Arts

**Restrictions:**

- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY205 Minimum Grade of D-
- PHY206 Minimum Grade of D- or PHY340 Minimum Grade of D-

May not be repeated for credit

**PHY345. Galaxies and Cosmology. 3 Credits.**

The Milky Way; the properties, contents, origins, and evolution of galaxies; the properties of their central black holes, active galaxies and starbursts; dark matter in galaxies and clusters; galaxy clustering and large-scale structure; models of the universe, its history and its future; the early Universe; and dark energy.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY340 Minimum Grade of C-

May not be repeated for credit

**PHY366. Nonlinear Dynamics. 3 Credits.**

A study of systems where a change of the output is not proportional to the change of the input. In the real world, systems are typically nonlinear.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- MAT341 Minimum Grade of C- or MAT359 Minimum Grade of C-

May not be repeated for credit

**PHY393. Physics Selected Topic. 1-12 Credits.**

Selected topics courses are regularly scheduled courses that focus on a particular topic of interest. Descriptions are printed in the Schedule of Classes each semester. Selected topics courses may be used as elective credit and may be repeated for credit, provided that the topic of the course changes.

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

May be repeated for credit

**PHY399. Modular Course. 0 Credits.****Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

May not be repeated for credit

**PHY402. Fluid Mechanics. 3 Credits.**

Fundamental physical characteristics, fluid statics; kinematics; flow of incompressible, compressible, and real fluids. Theory of models as applied to physical systems and development of several models of fluids.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY202 Minimum Grade of D-
- MAT341 Minimum Grade of C- or (MAT359 Minimum Grade of C- and MAT362 Minimum Grade of C-)

May not be repeated for credit

**PHY424. Advanced Physics Laboratory. 3 Credits.**

This course introduces students to advanced experiments in physics, experimental techniques in science research, and writing in a scientific research format. Topics include electricity and magnetism, quantum mechanics, optics, and nuclear physics. Emphasis is on implementing and investigating each experiment and communication observations through online forums, written notebooks, and research articles. Students will learn skills and knowledge that they can apply to future experimental research situations.

**Attributes:**

- Practicum - Non-Clinical
- Liberal Arts
- Writing Intensive

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY331 Minimum Grade of D-

May not be repeated for credit

**PHY429. Solid State Physics. 3 Credits.**

Crystals: Binding, symmetries, diffraction, reciprocal lattice, defects. Lattice dynamics: Phonons, modes, specific heat, thermal conduction. Metals: Free electron theory, band theory, superconductivity. Semiconductors: Fermi-Dirac Statistics, transport, band shapes, p-n junction, electronic devices.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY308 Minimum Grade of D-

May not be repeated for credit

**PHY432. Atomic and Nuclear Physics. 3 Credits.**

Elementary quantum mechanics applied to multielectron atoms, identical particles, magnetic effects and nuclear systems. Quantum nature of elementary particles. Selections from quantum statistics, solid state physics, superconductivity and magnetic properties of solids according to class interest.

**Attributes:**

- Liberal Arts

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

**Prerequisites:**

- PHY308 Minimum Grade of D-

May not be repeated for credit

**PHY491. Physics Senior Project (3-6). 3 Credits.**

Project may be either experimental or theoretical physics by arrangement with a physics faculty advisor. Plan must be approved in the prior semester by chairperson.

**Attributes:**

- Creative Works
- Research
- Critical Thinking Advanced
- Critical Think Reasoning Adv
- Information Literacy Advanced
- Information Mgmt Advanced

**Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

May be repeated for credit



### **PHY492. Physics Senior Project Continuation (1-3). 3 Credits.**

Continuation of senior project. Student must have completed PHY491 and have approval of chairperson.

#### **Attributes:**

- Creative Works
- Research

#### **Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

May not be repeated for credit

### **PHY493. Physics Selected Topic. 3-12 Credits.**

Selected topics courses are regularly scheduled courses that focus on a particular topic of interest. Descriptions are printed in the Schedule of Classes each semester. Selected topics courses may be used as elective credit and may be repeated for credit, provided that the topic of the course changes.

#### **Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

May be repeated for credit

### **PHY494. Fieldwork in Physics. 0 Credits.**

#### **Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

May not be repeated for credit

### **PHY495. Indep Study Physics. 1-12 Credits.**

#### **Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

May be repeated for credit

### **PHY499. Modular Course. 1 Credit.**

#### **Restrictions:**

- Must have the following level: Undergraduate
- Must not be enrolled in the following class: Freshman

May be repeated for credit