

# PHYSICS

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## PHY 110 Energy, Environment and Climate (4 Credits)

Our planet's reliance on carbon-based, non-renewable energy sources comes at a severe environmental, economic and political cost. Are there alternatives? This course offers a hands-on exploration of renewable energy technologies with an emphasis on understanding the underlying scientific principles. Students will assess worldwide energy demand, study the limits to improved energy efficiency, explore the science and technology of solar, wind, and hydropower, understand the science behind global warming, investigate climate models, and evaluate strategies for a sustainable future. This course also includes in-class experiments and field trips. {N}

**Fall, Spring, Variable**

## PHY 115 Quantitative Approaches to Physics (1 Credit)

Science blends physical knowledge with knowledge of math. This blending changes the meaning attached to math and even the way mathematical equations are interpreted. Learning to think about physics with math involves a number of scientific thinking skills that are rarely taught in introductory classes. Students in this course explicitly learn and practice these skills through individual and group work in a small class setting. Corequisite: PHY 117 or PHY 118; students are recommended for this course on the basis of a short placement test. Instructor permission required. (E)

**Fall, Spring**

## PHY 117 Introductory Physics I (5 Credits)

The concepts and relations (force, energy and momentum) describing physical interactions and the changes in motion they produce, along with applications to the physical and life sciences. Lab experiments, lectures and problem-solving activities are interwoven into each class. In-class discussion sections offer additional help with mathematics, data analysis and problem solving. This course satisfies medical school and engineering requirements for an introductory physics I course with a lab. Prerequisite: MTH 111 or equivalent. Enrollment limited to 28. {N}

**Fall, Spring**

## PHY 118 Introductory Physics II (5 Credits)

The concepts and relations (force fields, energy fields and potentials) underlying electrical, magnetic and gravitational interactions, as well as an exploration of simple harmonic motion, oscillations and waves. Lab experiments are integrated into the in-class lectures, discussions and problem solving activities. Satisfies medical school and engineering requirements for an introductory physics II course with lab. Prerequisite: PHY 117. Enrollment limited to 28. {N}

**Fall, Spring**

## PHY 119 Advanced Introductory Physics (5 Credits)

This course is designed for incoming students who have significant prior calculus-based experience with the topics covered in PHY 117 (Newtonian mechanics) and PHY 118 (electricity and magnetism), but who nevertheless would benefit from a course in introductory physics at the college level. Students will develop their problem-solving, experimental-design, data-analysis, scientific-computing and communication skills on a variety of more advanced applications of the standard introductory physics topics related to mechanics and E & M. Specific applications may include the physics of the solar system(s), numerical solution of  $F=ma$ , the atomic theory of matter, the laws of thermodynamics, electric circuits and electromagnetic waves. Pre-requisite: MTH 111 or equivalent. Enrollment limited to 28. Instructor permission required. {N}

**Fall**

## PHY 210 Mathematical Methods of Physical Sciences and Engineering (4 Credits)

This course covers a variety of math topics of particular use to physics and engineering students. Topics include differential equations, complex numbers, Taylor series, linear algebra, Fourier analysis, partial differential equations and a review of multivariate calculus, with particular focus on physical interpretation and application. Prerequisites: MTH 212 and (PHY 117 or PHY 119) or equivalent. Enrollment limited to 30. {M}{N}

**Fall, Spring**

## PHY 211 Computational Methods in the Physical Sciences (4 Credits)

This course provides an overview of commonly used computational methods and their applications to physics problems. Using the Python programming language, students begin with learning how programs send instructions to computers, move on to simple data visualization, error analysis and uncertainty in computational calculations, and then progress to numerical integration and differentiation, machine learning and stochastic methods. In each case, students examine the method's applications to relevant physics scenarios. This course will be project-based, with multiple short projects throughout the semester intended to build the skills and generate a set of modules that can be used as part of a final project applying a computational method to an appropriate physics problem of the student's choice. Enrollment limited to 30. (E) {M}{N}

**Fall**

## PHY 215 Light, Relativity, and Quantum Physics (4 Credits)

The special theory of relativity, the wave equation and mathematics of waves, optical phenomena of interference and diffraction, particle and wave models of matter and radiation, Bohr model of atomic structure, introduction to fundamental principles and problems in quantum mechanics, and introduction to nuclear physics. Prerequisite: (PHY 118 or PHY 119) and MTH 112. {N}

**Spring**

## PHY 240 Electronics (4 Credits)

A semester of experiments in electronics, with emphasis on designing, building and trouble-shooting circuits. Discrete electronic components: physics and applications of diodes and transistors. Analog and digital IC circuits: logic gates, operational amplifiers, timers, counters and displays. Final individual design project. Prerequisite: PHY 118 or PHY 119 or equivalent. Priority given to physics majors and minors, and students planning to major or minor in Physics. Enrollment limited to 18. Instructor permission required. {N}

**Fall**

**PHY 242 Research in High Precision Spectroscopy (3 Credits)**

This course gives students a practical introduction to experimental atomic physics by having you do real, publishable research. While this course-based research program is focused on high precision spectroscopy, students gain skills that can be generally applied to investigational science in experimental design, experimental iteration and systematic error analysis, data analysis, and writing scientific papers for publication. In addition, students learn about basic atomic physics and quantum mechanics, atom and light interactions, and optics, and they gain a basic understanding in how experiment and theory interact to further the knowledge of nature. Corequisite: PHY 242L. Enrollment limited to 12. (E) {N}

**Fall, Spring, Variable**

**PHY 242L Laboratory in High Precision Spectroscopy (1 Credit)**

This lab course gives students a practical introduction to experimental atomic physics by having you do real, publishable research. While this course-based research program is focused on high precision spectroscopy, students gain skills that can be generally applied to investigational science in experimental design, experimental iteration and systematic error analysis, data analysis, and writing scientific papers for publication. In addition, students learn about basic atomic physics and quantum mechanics, atom and light interactions, and optics, and they gain a basic understanding in how experiment and theory interact to further the knowledge of nature. Corequisite: PHY 242. Enrollment limited to 4. (E) {N}

**Fall, Spring, Variable**

**PHY 300 Physics Pedagogy: Theory (2 Credits)**

A course emphasizing the pedagogy in physics based on Physics Education Research (PER). Readings and discussion emphasize the research literature and strategies for implementing successful and effective methods of teaching physics at the introductory level in the classroom. May be repeated once for credit. Prerequisites: PHY 117, PHY 118 or PHY 119. Instructor permission required. {N}

**Fall, Spring**

**PHY 301 Physics Pedagogy: Practicum (2 Credits)**

A practicum course involving actual classroom experience in implementing methods of teaching based on Physics Education Research (PER). Students have direct interaction with learners in the classroom during group activities, laboratory exercises and problem-solving. May be repeated once for credit. Corequisite: PHY 300. Prerequisites: PHY 117, PHY 118 or PHY 119. Instructor permission required. {N}

**Fall, Spring**

**PHY 317 Classical Mechanics (4 Credits)**

Newtonian dynamics of particles and rigid bodies, oscillations and planetary orbits. Prerequisite: PHY 215 or equivalent. {N}

**Fall**

**PHY 318 Electricity and Magnetism (4 Credits)**

Electrostatic and magnetostatic fields in vacuum and in matter, electrodynamics and electromagnetic waves. Prerequisite: PHY 215 or equivalent. {N}

**Fall, Spring, Alternate Years**

**PHY 319 Thermal Physics (4 Credits)**

Introduction to statistical mechanics and thermodynamics. Prerequisites: PHY 215 or equivalent. {N}

**Fall, Spring, Alternate Years**

**PHY 327 Quantum Mechanics (4 Credits)**

The formal structure of nonrelativistic quantum mechanics, including operator methods. Wave packets; quantum mechanical scattering and tunneling; central potentials; matrix mechanics of spin, addition of angular momenta; corrections to the hydrogen spectrum; identical particles and exchange symmetry; EPR paradox, Bell's Theorem and the interpretation of quantum mechanics. Prerequisites: PHY 215 or equivalent. PHY 317 recommended. {N}

**Spring**

**PHY 350 Experimental Physics (4 Credits)**

An advanced laboratory course for juniors and seniors in which students learn and make use of advanced signal recovery methods to design and perform laboratory experiments drawn from a wide range of topics in modern and contemporary physics. Students planning on special studies or honors work in experimental physics as seniors should take PHY 350 during their junior year. Prerequisites: PHY 215 and PHY 240 or equivalent. Enrollment limited to 12. {N}

**Spring**

**PHY 360gr Advanced Topics in Physics-General Relativity (4 Credits)**

This course covers the basics of general relativity. The class discusses tensors and metric spaces and re-frames special relativity in those terms. Students then generalize the rules of special relativity to non-inertial frames and use the equivalence principle to extend those ideas to spaces with gravitational fields. The class explores "Einstein's equation" relating matter and geometry. Finally, students discuss basic applications, including black holes, gravitational waves and cosmology. Prerequisites: PHY 210 and PHY 215, or equivalent. {N}

**Fall, Spring, Variable**

**PHY 360op Advanced Topics in Physics-Optics (4 Credits)**

Electromagnetic waves; polarization and polarizing devices; reflection and refraction at interfaces; optical properties of dielectrics and metals; birefringent materials and devices; multiple beam interference and interferometers; diffraction and optical resolution; lasers. {N}

**Fall, Spring, Variable**

**PHY 400 Special Studies (1-4 Credits)**

By permission of the department.

**Fall, Spring**

**PHY 410 Capstone Physics (1 Credit)**

This course is intended to give students who plan to continue in graduate school with the study of physics (or a related discipline) an opportunity to synthesize bodies of knowledge from the different sub-disciplines of physics. Administering of GRE practice exams will be used as an assessment tool of this understanding and of relevant analytical skills needed for problem-solving. {N}

**Fall, Spring, Variable**

**PHY 430D Honors Project (4 Credits)**

**Fall, Spring, Annually**

**PHY 432D Honors Project (4 Credits)**

This is a full-year course.

**Fall, Spring**