Physics

Professors: Askew, Cole (Chair), Érdi, Tobochnik, Wilson

The physics curriculum at Kalamazoo College provides preparation for the potential physicist as well as a solid background for students in the other sciences. A student majoring in physics can pursue further study in physics, engineering, computer science, astronomy, medical physics, or environmental science. Other opportunities include teaching at the high school level and working in a business that involves modern technology, and other careers such as finance, patent law, and technical editing.

Students interested in majoring in one of the physical sciences should plan to take CHEM 110, MATH 112-113, and PHYS 150 during the first two quarters of the first year.

Students with an AP score of 4 or 5 on the Physics C-Mechanics exam will also be granted credit in PHYS 150 and should begin their sequence with PHYS 152. Students with the same score on the Physics C-E&M exam will also be granted credit in PHYS 152 and should begin their sequence with PHYS 220. Students may also receive credit for PHYS 152 by receiving a 5,6, or 7 on the IB Physics HL exam.

Students planning on a major in physics should achieve at least "B" level academic work in the department by the time they complete PHY 220.

Students interested in engineering should consider the combined curriculum in engineering. This typically follows the program of the physics major during the first three years. (See the 3/2 Engineering Program description.)

Requirements for the Major in Physics

Number of Units
Eight courses in physics, numbered 150 and higher, with a minimum grade of C- are required for the major. A SIP in physics is not required for the major and, if completed, does not count toward the eight courses. A maximum of one AP, IB, dual enrollment, transfer, or study abroad credit may be counted toward the eight courses. Any number of required cognates may be met with AP, IB, dual enrollment credit, or local placement exam results. Departmental approval is required for all use of AP, IB, dual enrollment credit, and transfer credit toward major requirements. *Students transferring from another college or university may receive credit for multiple courses in physics, subject to Departmental approval.*

Required Courses
PHYS 150, 152, Introductory Physics I and II, with Lab
PHYS 220 Intro to Relativity and Quantum Physics with Lab
PHYS 340 Classical Dynamics with Lab
PHYS 360 Thermal Physics with Lab
PHYS 370 Electronics and Electromagnetism with Lab
PHYS 380 or PHYS 410, Semiconductors and Magnetism with Lab or Advanced Electricity and Magnetism

Required Cognates
MATH 112, 113, and 214 Calculus I, II, and III
MATH 240 Linear Algebra and Vectors
MATH 280 Differential Equations and Numerical Methods
All cognates in math must be at C- or above.

Successful completion of the major requires taking a departmental comprehensive exam, normally offered in late January of the senior year. The Advanced Physics GRE exam may be used in place of the locally administered departmental exam.

A least one course in Computer Science, one course in Complex Systems, and MATH 310, Complex and Vector Variables, are recommended for all students in the major. Students planning on graduate study in Physics, Applied Physics, or

Electrical Engineering should take both PHYS 380 and 410, and PHYS 420, Quantum Mechanics. Students interested in further study in environmental engineering or related programs should take CHEM 110 and 120, and consider additional coursework in chemistry and biology. Students interested in biological physics or neuroscience should explore the concentrations available in those
subjects.

Requirements for the Minor in Physics

Number of Units
Six units, exclusive of lab credit, in Physics are required, with a minimum grade of C-.

Required Courses
PHYS 150, 152 Introductory Physics I, II with Lab
PHYS 220 Intro to Relativity and Quantum Physics with Lab
Three additional physics courses, two at the 200 level or above and at least one at the 300 level or above.

Students may not major in 3/2 engineering and minor in physics.

Physics courses

PHYS 102 Astronomy
Study of modern astronomy beyond the solar system: stars, galaxies, pulsars, quasars, black holes, and cosmology. Emphasis on fundamental physics and its application to understanding the structure and evolution of astronomical objects.

PHYS 105 Energy and the Environment
Application of scientific concepts and analyses to the study of the production, conversion, and consumption of energy, and an understanding of the associated environmental and societal implications. Designed primarily for students not majoring in the physical sciences; especially appropriate for those in the environmental studies concentration.

PHYS 150 Introductory Physics I with Lab
Conceptual and practical study of the basic conservation laws (momentum, energy, and angular momentum) and the Newtonian world view.
Prerequisite: MATH-111 or MATH-112 All course prerequisites must be met with a minimum grade of C-.

PHYS 152 Introductory Physics II with Lab
Study of the fundamental and practical concepts associated with electric and magnetic fields and their unification.
Prerequisite: PHYS-150 and MATH-111 or MATH-112 All course prerequisites must be met with a minimum grade of C-.

PHYS 205 Applications of Physics in the Biosciences
How can we observe nano-scale biological systems? How does the flexibility of a molecule contribute to its biological function? How can we make sense of vast amounts of complex and sometimes "messy" biological data? This course is an introduction to the advantages and limitations of using physical techniques and models to address biological questions. We will focus on molecular-scale systems and dynamics, with topics to include optics and microscopy, physical properties of biomolecules, and modeling dynamic molecules and systems. Current biophysical research and interdisciplinary communication skills will be emphasized through periodic discussion of articles from the primary literature.
Prerequisite: BIOL-112 and PHYS-150 or Instructor Permission All course prerequisites must be met with a minimum grade of C-.

PHYS/IDSY 215 Introduction to Complex Systems
Study of how collective behavior emerges from the interaction between a system's parts and its environment. Model systems from the natural sciences and social sciences will be used as examples. Both historical and contemporary approaches will be discussed.

PHYS 220 Introduction to Relativity and Quantum Physics with Lab
Study of light, special relativity, and quantum physics with applications.
Prerequisite: PHYS-152 and MATH-113. (MATH-214 & 240 recommended.) All course prerequisites must be met with a minimum grade of C-.

PHYS/MATH 270 Nonlinear Dynamics and Chaos
Dynamical systems are mathematical objects used to model phenomena of natural and social phenomena whose state changes over time. Nonlinear dynamical systems are able to show complicated temporal, spatial, and spatiotemporal behavior. They include oscillatory and chaotic behaviors and spatial structures including fractals. Students will learn the

basic mathematical concepts and methods used to describe dynamical systems. Applications will cover many scientific disciplines, including physics, chemistry, biology, economics, and other social sciences. Appropriate for Math or Physics Majors. Either MATH 305 or this course, but not both, may be counted towards the major in mathematics.
Prerequisite: MATH-113 All course prerequisites must be met with a minimum grade of C-.

PHYS 340 Classical Dynamics with Lab
Study of classical dynamics emphasizing physical reasoning and problem solving. The Newtonian, Lagrangian, and Hamiltonian formulations are discussed, and applications are made to planetary motion, oscillations, stability, accelerating reference frames, and rigid body motion.
Prerequisite: PHYS-152 and MATH-280 All course prerequisites must be met with a minimum grade of C-.

PHYS 360 Thermal Physics with Lab
Introduction to thermal physics with emphasis on a statistical approach to the treatment of thermodynamic properties of bulk material.
Prerequisite: PHYS-220. (MATH-280 recommended.) All course prerequisites must be met with a minimum grade of C-.

PHYS 370 Electronics and Electromagnetism with Lab
Basic concepts of analog and digital electronics are taught along with intermediate level electrostatics and electrodynamics. Mathematical topics include introductory vector calculus and field theory. The laboratory portion emphasizes circuit analysis, measurement technique, and the skillful use of modern digital instrumentation.
Prerequisite: PHYS-220 and co-enrollment in or completion of MATH-280. All course prerequisites must be met with a minimum grade of C-.

PHYS 380 Semiconductors and Magnetism with Lab
The relationship between electricity and magnetism is studied through the introduction of Maxwell's equations. Semiconductor material properties are studied, along with device instructions for diodes, transistors, and simple integrated circuits. The laboratory portion emphasizes circuit construction techniques, device characterization, amplifier design and feedback, and signal/noise analysis.
Prerequisite: PHYS-370 and MATH-280 All course prerequisites must be met with a minimum grade of C-.

PHYS 410 Advanced Electricity and Magnetism with Lab
Study of electromagnetic field theory, electrostatics, potential theory, dielectric and magnetic media, Maxwell's field equations, and electromagnetic waves; vector calculus developed as needed.
Prerequisite: PHYS-370 and MATH-280 All course prerequisites must be met with a minimum grade of C-.

PHYS 420 Quantum Mechanics with Lab
Study of the principles and mathematical techniques of quantum mechanics with applications to barrier problems, the harmonic oscillator, and the hydrogen atom.
Prerequisite: PHYS-340 and MATH-280 All course prerequisites must be met with a minimum grade of C-.

PHYS 480 Special Topics Techniques
Special Topics offerings focus on a physics topic not addressed in the department's regular offerings. Possible topics include general relativity and cosmology, solid state physics, particle physics, soft condensed matter physics, biological physics, advanced laboratory techniques, and fluid mechanics. Check the course schedule to see when Special Topics courses are being offered.

PHYS 481 Special Topics: General Relativity & Cosmology
General relativity is a geometric theory of gravity which has significant implications upon cosmology from gravitational redshift and bending of light rays to black holes and the large scale structure of the universe. We will learn to use tensors to perform calculations and study the implications of the Einstein equation.

PHYS 482/IDSY 305/MATH 305 Special Topics: Dynamic Models in Social Sciences
The study of why mathematical and computational methods are important in understanding social phenomena, and how different social phenomena can be described by proper mathematical models. Specifically, applications of the theory of dynamical systems will be presented. Designed for math/science and social science students. Either MATH/PHYS 270 or this course, but not both, may be counted towards the major in mathematics.

PHYS 483 Advanced Quantum Mechanics With Lab
We will study special topics in quantum mechanics, including perturbation theory, solid state physics and quantum computing. Prerequisite: PHY 420
Prerequisite: Take PHYS-420

PHYS 593 Senior Individualized Project
Each program or department sets its own requirements for Senior Individualized Projects done in that department, including the range of acceptable projects, the required background of students doing projects, the format of the SIP, and the expected scope and depth of projects. See the Kalamazoo Curriculum -> Curriculum Details and Policies section of the Academic

Catalog for more details.
Prerequisite: Permission of department and SIP supervisor required.