Physics (PHY)

Notes:

1. Consult the physics placement guide for assistance in selecting beginning courses.
2. Contact the department chair or lead departmental advisor for appropriate physics course selection if you receive Advanced Placement credit in physics.
3. Credit for graduation will be given for only one of PHY161 and PHY181, and credit for graduation will be given for only one of PHY162 and PHY182.

PHY 101. Physics and Society. (3)
An introduction to the fundamental principles and processes of the physical world, ranging from classical mechanics to modern physics. By taking a "concepts before calculations" approach, the course engages student with real-world analogies and applications, highlighting the interaction between science and society. Qualitative reasoning is emphasized and basic quantitative problem-solving skills are developed. Provides skills for thinking critically about societal problems having a scientific or technological component. IVB. PA-2B. CAS-D.

PHY 103. Concepts in Physics Laboratory. (1)
Laboratory course illustrating the basic concepts of physics. For the general student; complements physics lecture offerings at the nonspecialist level. IVB, LAB. PA-2B. CAS-D/LAB.
Prerequisite or Co-requisite: PHY 101, 111, 121, 131, or 141.

PHY 111. Astronomy and Space Physics. (3)
An introduction to the modern science of astronomy. Topics covered include history, basic astrophysical science, planetary science, stellar astrophysics, galactic astronomy, cosmology, and the question of extraterrestrial life. Suitable for students with or without a technical background. IVB. PA-2B. CAS-D.

PHY 121. Energy and Environment. (3)
Application of physics principles and models to societal uses of energy. Includes mechanics, electricity and magnetism, thermodynamics, and atomic and nuclear physics. Energy topics include resources, environmental problems, global atmospheric challenges, nuclear power, solar energy, alternative energy systems, and energy conservation. Algebraic skills are required but no previous course in physics is needed. IVB. PA-2B, SI-01. CAS-D.

PHY 131. Physics for Music. (3)
Introduction to the basic physics of sound within the context of music. Topics covered include production, transmission, and reception of sound waves; traditional and electronic musical instruments; and the physics of sound reproduction. IVB. PA-2B. CAS-D.

PHY 141. Physics in Sports. (3)
Various aspects of a dozen or more sports are treated using the laws of physics. Provides the non-science student with insight into principles governing motion, dynamics, and other elements of physics in sports. IVB. PA-2B, SI-05. CAS-D.
Cross-listed with KNH 141.

PHY 161. Physics for the Life Sciences with Laboratory I. (4)
The course is a quantitative introduction to the basic physical laws of nature. Kinematics, Newtonian dynamics, energy and momentum, gravity, fluids, and thermodynamics are emphasized. Concepts are developed through lectures, demonstrations, hands-on laboratory explorations, computer simulations, and problem solving. Qualitative reasoning is emphasized, and quantitative problem-solving skills are developed. Concepts from algebra and trigonometry are used and integrative thinking skills are developed. IVB. PA-2B. CAS-D-LAB.
Prerequisite: ACT math score of 26 or higher; or SAT math score of 610 or higher; or Miami Math Placement Test score of 16 or higher; or MTH 124 or MTH 125 or MTH 135 or MTH 151.

PHY 162. Physics for the Life Sciences with Laboratory II. (4)
The course is a quantitative introduction to the basic physical laws of nature. Oscillations, waves (including sound and light), optics, electricity and circuits, magnetism, and an introduction to atomic, quantum, and nuclear physics are emphasized. Concepts are developed through lectures, demonstrations, hands-on laboratory explorations, computer simulations, and problem solving. Qualitative reasoning is emphasized, and quantitative problem-solving skills are developed. Concepts from algebra and trigonometry are used and integrative thinking skills are developed. IVB. PA-2B. CAS-D-LAB.
Prerequisite: PHY 161 or PHY 181 or equivalent.

PHY 177. Independent Studies. (0-6; maximum 10)

PHY 181. General Physics I. (4)
The course is a quantitative introduction to the basic physical laws of nature. Kinematics, Newtonian dynamics, energy and momentum, gravity, oscillations, waves, and quantum physics are emphasized. Concepts are developed through lectures, demonstrations, computer simulations, and problem solving. Qualitative reasoning is emphasized, and quantitative problem-solving skills are developed. Concepts from differential and integral calculus are developed and used. IVB. PA-2B. CAS-D.
Co-requisite: MTH 151 or equivalent.

PHY 182. General Physics II. (4)
The course is a quantitative introduction to the basic physical laws of nature. Thermodynamics, electricity and magnetism, circuits, Maxwell's Equations, and special relativity are emphasized. Concepts are developed through lectures, demonstrations, computer simulations, and problem solving. Qualitative reasoning is emphasized, and quantitative problem-solving skills are developed. Concepts from differential and integral calculus are developed and used. IVB. PA-2B. CAS-D.
Prerequisite: MTH 151 or equivalent, PHY 181 or equivalent.
Co-requisite: MTH 249, MTH 251 or equivalent.

PHY 183. General Physics Laboratory I. (1)
Laboratory course for students enrolled in PHY 181. Laboratory experiments in mechanics, energy, waves, and quantum phenomena are performed. IVB. PA-2B. CAS-D.
Co-requisite: PHY 181.

PHY 184. General Physics Laboratory II. (1)
Laboratory course for students enrolled in PHY 182. Laboratory experiments in thermal physics, electricity, magnetism, and circuits are performed. IVB. PA-2B. CAS-D.
Co-requisite: PHY 182.

PHY 185. Experiencing The Physical World. (1)
The course provides enrichment activities for students enrolled in PHY 181 or PHY 182. As a First-Year Experience course, students learn about resources in the in the Physics Department and at Miami University, establishing a foundation for academic and co-curricular success.
Co-requisite: PHY 181, or PHY 182, or permission of instructor.

PHY 215. Physics by Inquiry. (3)
For middle and adolescent level education majors seeking licensure in science. Emphasizes scientific inquiry in an activity-based, cooperative-learning approach. Goals are to develop basic physical concepts and the scientific reasoning skills necessary to apply them to the natural world and to serve as a model for the transfer of the methods of inquiry-based instruction and authentic assessment to the precollege classroom. Topics selected from properties of matter, thermodynamics, electricity, optics, kinematics, and astronomy. Assessments include laboratory notebook and journal writing, discussion, and developing and teaching inquiry lessons.
Prerequisite: one year of physical science or permission of instructor.

PHY 277. Independent Studies. (0-6; maximum 10)

PHY 281. Contemporary Physics I: Foundations. (3)
The course emphasizes special relativity and quantum physics, and the development of quantitative problem-solving skills necessary for the application of advanced physics concepts. The PHY 281/282 sequence provides a solid conceptual and mathematical foundation for students continuing with advanced physics courses. It is also valuable as a terminal physics sequence for students in physics-related fields.
Prerequisite: PHY 182.
Co-requisite: MTH 252 (or permission of instructor).

PHY 282. Contemporary Physics II: Frontiers. (3)
The course is a continuation of PHY 281 with further quantitative development of quantum and statistical physics, covering enabling tools and techniques from atomic, molecular, condensed matter, nuclear and particle physics, as well as advances in nanotechnology, quantum optics, and biophysics. The PHY 281/282 sequence provides a solid conceptual and mathematical foundation for students continuing with advanced physics courses. It is also valuable as a terminal physics sequence for students in physics-related fields.
Prerequisite: PHY 281.

PHY 286. Introduction to Computational Physics. (3)
A course on use of computers in analyzing physical systems. Topics of study come from classical mechanics, electromagnetism, statistical physics, and quantum mechanics.
Prerequisite: PHY 182, MTH 251.

PHY 292. Electronic Instrumentation. (2)
Theory and application of electronic instrumentation for scientists with emphasis on data acquisition and analysis.
Prerequisite: PHY 182.
Co-requisite: PHY 294.

PHY 293. Contemporary Physics Laboratory. (2)
Designed for students majoring in physics. Focuses on Nobel prize-winning physics research occurring within the lifetime of the student. Topics may include Balmer series of hydrogen, high-Tc superconductivity, x-ray diffraction, and magnetism. Communication skills are developed through report writing, presentations, and manuscript writing. CAS-D/LAB. CAS-W.
Prerequisite: PHY 192.
Co-requisite: PHY 282.

PHY 294. Laboratory in Electronic Instrumentation. (2)
Laboratory experience in the use of electrical and electronic instruments, application of transducers and data acquisition equipment. Use of computer in analyzing data and interfacing computer with experiments.
Co-requisite: PHY 292.

PHY 340. Internship. (0-20)

PHY 377. Independent Studies. (0-6; maximum 10)

PHY 400/PHY 500. Physics Seminar. (1; maximum 4)
Weekly physics colloquium series presenting guest speakers on topics of interest to scientific community. Required of all graduate students in residence. Offered for credit/no-credit only.
Prerequisite: PHY 192 or equivalent or permission of faculty in charge.

PHY 401. Physics Assessment Examination. (0)
Standardized assessment examination for physics majors.
Prerequisites: PHY282 and senior standing.

PHY 410. Topics in Physics Seminar. (1-3; maximum 12)
Directed study in selected topics in physics. Includes reading, research, writing, reporting, and discussion.

PHY 421/PHY 521. Molecular and Cellular Biophysics. (4)
Introduction to physical phenomena acting on molecular and cellular size scales, including transport properties; thermodynamics and statistical mechanics of reactions; self-assembly; and fluctuations. Development of physical models for biological systems and phenomena, including cooperative behavior in macromolecules; enzyme activity; molecular motors and machines; energy transduction; and nerve transmission.
Prerequisite: PHY 162 or PHY 192, MTH 252, or permission of instructor.

PHY 430/PHY 530. Topics in Physics. (1-4; maximum 12)
Study of topics of current interest in physics beyond the coverage in other course offerings.
Prerequisite: senior or graduate standing in physics or permission of instructor.

PHY 437/PHY 537. Intermediate Thermodynamics and Introduction to Statistical Physics. (4)
Development of formal thermodynamics including first, second, and third laws, thermodynamic potentials, Maxwell's relations, phase transitions, and illustrative applications of thermodynamics. Introduction to kinetic theory approach to behavior of systems not in equilibrium, Boltzmann Equation, and transport processes. Development of statistical mechanics and ensemble approach to equilibrium statistical thermodynamics. Pre- or co-requisite: PHY 483/PHY 583 or permission of instructor.
Prerequisite: PHY 281.

PHY 440. Research. (1-4; maximum 12)
Undergraduate research projects with direction of faculty member.
Prerequisite: permission of instructor.

PHY 441/PHY 541. Optics and Laser Physics. (4)
Lecture and laboratory course covering all aspects of lasers and their applications. Teaches basics of physical and geometrical optics and atomic physics in detail to understand the design, operation, and application of lasers. Topics include gaussian beams, cavity design, rate equation models of laser gain media, different types of lasers, and nonlinear optics.
Prerequisite: PHY 281, PHY 293, or permission of instructor.

PHY 442/PHY 542. Spectroscopy of Atoms and Molecules. (4)
Survey of the structure of atoms and molecules, using optical spectroscopy as a tool. Lecture reviews the quantum theory of atoms and molecules, including solutions to the Schroedinger equation, spectroscopic notation, transition rates, and selection rules. Laboratory examines a variety of light sources, with increasing resolution. Zeeman, fine structure, and hyperfine structure, in particular, are considered. Emphasis on laboratory investigation. Pre- or co-requisite: PHY 483/PHY 583.
Prerequisite: PHY 281, PHY 293, or permission of instructor.

PHY 451/PHY 551. Classical Mechanics. (4)
Mechanics, nonrelativistic and relativistic, of particles, systems of particles, and rigid bodies treated by Newtonian, Langrangian, and Hamiltonian methods using vector and matrix analysis and calculus of variations. Pre- or co-requisite: PHY 483/PHY 583 or permission of instructor.

PHY 461/PHY 561. Electromagnetic Theory. (4)
Mathematically quantitative lecture and problem course in theory of electromagnetism. Topics include multipole fields, electromagnetic field equations, electromagnetic waves, reflection and refraction, radiating systems, classical electron theory, spherical waves, interference phenomena, and diffraction theory.
Prerequisite or Co-requisite: PHY 483/PHY 583 or permission of instructor.

PHY 467. Seismology. (3)
Active learning course on seismology covering theory and application. Topics will include elastic wave propagation, reflection/refraction seismology, waveform modeling, tomography plate kinematics, and time series analysis. Applications will focus on earthquakes and large-scale tectonics.
Prerequisites: MTH 151 or MTH 153; PHY 161 or PHY 162 or PHY 181 or PHY 182; or consent of instructor.
Cross-listed with GLG 467/GLG 567.

PHY 477. Independent Studies. (0-6; maximum 10)

PHY 480. Departmental Honors. (1-6; maximum 6)
Departmental honors may be taken for a minimum of four semester hours and a maximum total of six semester hours, in one or more semesters of the student's senior year.

PHY 481/PHY 581. Gravitation and Spacetime. (3)
Beginning with the Lorentz invariance of Maxwell's equations, a relativistic theory of motion is described for inertial reference frames. This forms a framework for discussing Einstein's theory of gravitation.
Prerequisite: PHY 483/PHY 583 or instructor permission.

PHY 483/PHY 583. Mathematical Methods in Physics. (4)
Discusses mathematical methods applicable to classical mechanics, quantum mechanics, and electromagnetism. Develops problem-solving skills by applying material from introductory math and physics classes along with new mathematical techniques. Allows for modeling of systems at a deeper level. Emphasizes the use of mathematics to model physical systems and methods of solutions to the differential equations of physics.
Prerequisite: PHY 281; MTH 222, MTH 252.

PHY 486/PHY 586. Advanced Computational Physics. (3)
Develops computational skills necessary to apply mathematics and physics to the investigation and solution of non-analytic problems of physical interest. Topics will include, but are not limited to, celestial mechanics, fluid mechanics, and quantum mechanics. The physical basis of these topics can often be understood at the undergraduate level, but require sophisticated computational methods for their actual solution. This course will develop and apply those methods.
Prerequisite: PHY 286 and PHY 483/PHY 583.

PHY 488. Research Capstone in Physics. (3)
This course is an intensive, research-based capstone experience in the format of an individual study. The student will identify and develop a research project, perform necessary research activities, write a journal-style research report, and communicate research findings to other students and faculty in a conference-style presentation. The student must identify a faculty research advisor prior to enrolling in this individual-study course. SC. Senior standing and at least one semester of prior research involvement with the research advisor is typically needed to receive permission.
Prerequisites: Permission of a faculty research advisor and the capstone coordinator.

PHY 491/PHY 591. Introduction to Quantum Mechanics I. (4)
Introduction to the quantum theory and its application to physical systems. Pre- or co-requisite: PHY 483/PHY 583, or permission of instructor.
Prerequisite: PHY 281.

PHY 610. Research. (1-10; maximum 10)
Independent research projects in theoretical or experimental physics.

PHY 620. Topics in Modern Physics. (1-4; maximum 10)
Study of various topics of interest in physics not covered in formal course offerings.
Prerequisite: Permission of instructor.

PHY 642. Advanced Kinetic Theory and Statistical Mechanics. (4)
Transport theory of gases; Chapman-Enskog development. Classical and quantum statistical mechanics with applications to many-particle systems.

PHY 651. Quantum and Nonlinear Optics. (3)
The basics of electromagnetic interactions with matter are covered, including quantum and semiclassical theories of the laser, cavity quantum-electrodynamics, hamonic generation and down-conversion, the cooling and trapping of atoms, and quantum information theory.
Prerequisite: PHY 691 or instructor permission.

PHY 671. Electromagnetism. (4)
Electromagnetic theory and applications.
Prerequisite: PHY 461/PHY 561 or permission of instructor.

PHY 677. Independent Studies. (0-6; maximum 10)

PHY 691. Modern Quantum Physics. (4)
Fundamental concepts of quantum mechanics and the mathematical techniques of Schrodinger and Heisenberg. Computer solution of quantum mechanical problems.
Prerequisite: PHY 491/PHY 591 or permission of instructor.

PHY 692. Modern Quantum Physics. (4)
Fundamental concepts of quantum mechanics and the mathematical techniques of Schrodinger and Heisenberg. Computer solution of quantum mechanical problems.
Prerequisite: PHY 691.

PHY 700. Research for Master's Thesis. (1-12; maximum 12)

PHY 850. Research for Doctoral Dissertation. (1-16)