

PHYSICS (PHYS)

PHYS 100 Introduction to Physical Science (4 credits)

This is a one semester physical science course with laboratory designed for those students not majoring in science areas. This course will introduce the student to the scientific method while teaching some principles of physical science and their applications. Topics include: introduction to the laws of motion, work and energy, heat, climate change, sound, light, electricity, and applications from modern technology.

PHYS 104 History of Science (3 credits)

The historical and philosophical development of science traced from the ancient Egyptians to the present.

PHYS 106 Science and Society (3 credits)

This is a one semester course for non-science majors designed to provide knowledge of some of the principles of physical science and to indicate how they are related to society. Formal laboratory is not included in the course. Topics discussed vary but may include energy and sustainability, climate change, radiation, electricity and magnetism, space exploration, and technological applications of physics.

PHYS 109 Energy and Climate Change (3 credits)

The physics of energy and climate change. The course will focus on issues such as the current energy crisis, alternative energy efforts and the scientific data indicative of climate change and global warming. Satisfies SEEDS Scientific Reasoning student learning outcome in alignment with Educated Citizenry value.

PHYS 180 Astronomy for Everyone (4 credits)

An introduction to astronomy suitable for all audiences. Traces the evolution of the universe from the Big Bang, through the formation of galaxies, stars, planets, and life. Additional topics include the nature of space and time, black holes and gravitational waves, cosmology, galaxy collisions and spiral structure, methods for observing the universe, understanding the night sky, overview of the solar system, exoplanets, and life in the universe. Labs include telescopic observations, spectroscopy, optics, and computer simulations. Field trips or occasional meetings outside of the regularly scheduled class time may be required. Satisfies Natural Science Lab GenEd requirement; satisfies SEEDS Quantitative Reasoning student learning outcome in alignment with Educated Citizenry and Social Justice and Equity values.

PHYS 190 Introductory Mathematics and Computing for the Physical Sciences and Engineering (4 credits)

Prerequisite(s): A score of 76 or higher on the ALEKS Placement Assessment; or MATH 122, AMAT 120, MATH 221, or AMAT 220 may be taken concurrently. This course reviews and previews mathematics and computing topics from the standpoint of practical skills needed by majors in physical science and engineering disciplines. Topics include: review of concepts from algebra, geometry, trigonometry, dimensional analysis, complex numbers, and vector analysis as applied in introductory physics; introduction to basic calculus concepts and techniques (differentiation/integration); series expansions; a basic overview of ordinary differential equations (ODEs) as used in introductory physics; and an overview of statistical concepts and data analysis as applied in physical science experiments. The laboratory portion of the course will focus on basic computing skills as applied in the physical sciences and engineering. This includes learning multiple computing environments to make plots, analyze data, perform symbolic algebraic and calculus operations, and perform numerical integration, root finding, and basic numerical ODE solving. Placement in PHYS 190 is based on initial math placement and departmental advisement. All new physics majors placed into MATH 111 are expected to complete PHYS 190 simultaneous with enrollment in MATH 122 or AMAT 120. Enrollment for other physics majors who have not already completed the PHYS 191/192 sequence is strongly recommended. See your department advisor for further guidance. This course does not meet any General Education requirements.

PHYS 191 University Physics I (4 credits)

Prerequisite(s): MATH 122 or AMAT 120 or MATH 221 or AMAT 220 may be taken as a corequisite or taken as a prerequisite, with a grade of C- or higher; or MATH 111 as a prerequisite, with a grade of C- or higher, and a corequisite of MATH 122 or AMAT 120. This one-semester calculus-based course including laboratory is a study of the principles of physics and their applications, with a focus on mechanics. Topics covered include kinematics, force, Newton's laws of motion, work and energy, momentum, rotational motion, torque, angular momentum, conservation laws, gravity, and harmonic motion. Satisfies Natural Science Lab GenEd requirement; satisfies SEEDS Scientific Reasoning student learning outcome in alignment with Educated Citizenry value.

PHYS 192 University Physics II (4 credits)

Prerequisite(s): PHYS 191 with a grade of C- or higher; and MATH 221 or AMAT 220 may be taken as a prerequisite or corequisite. Second half of the calculus-based introductory physics sequence (following PHYS 191); includes laboratory. Focus is on the following topics: oscillations and waves, sound, optics, electricity, magnetism, and circuits. Some applications to modern physics also discussed.

PHYS 193 College Physics I (4 credits)

Prerequisite(s): MATH 100, MATH 111, or placement in a higher level Calculus course (MATH 122, MATH 221, MATH 222, AMAT 120, AMAT 220), or a score of 76 or higher on the ALEKS Placement Assessment. This one semester course including laboratory is a study of the principles and applications of classical physics. Topics covered include mechanics, Newton's laws of motion, work and energy, momentum, rotational motion, heat and thermodynamics, as well as modern applications of physical principles. Calculus is not used, but algebra and trigonometry are required.

PHYS 194 College Physics II (4 credits)

Prerequisite(s): PHYS 193. This one semester course including laboratory is a study of the principles and applications of classical physics. Topics covered include oscillations and waves, sound, optics, electricity and magnetism, an introduction to modern and nuclear physics, as well as contemporary applications of physical principles. Calculus is not used, but algebra and trigonometry are required.

PHYS 195 Problem Solving in Physics I (1-2 credits)

Prerequisite(s): PHYS 191 may be taken as prerequisite or corequisite. Serves as a supplement to PHYS 191, providing additional time for problem-solving practice in areas of mechanics: kinematics, forces, momentum, energy, conservation laws, rotation, torque, angular momentum, and gravity. Emphasizes group problem-solving activities. Required for physics majors enrolled in PHYS 191; and optional, but strongly recommended, for all others enrolled in PHYS 191. May be repeated for a maximum of 4 credits.

PHYS 196 Problem Solving in Physics II (1-2 credits)

Prerequisite(s): PHYS 192 may be taken as prerequisite or corequisite. Serves as a supplement to PHYS 192, providing additional time for problem-solving practice in areas of electricity, magnetism, oscillations, waves, and optics. Required for physics majors enrolled in PHYS 192; and optional, but strongly recommended, for all others enrolled in PHYS 192. May be repeated for a maximum of 4 credits.

PHYS 198 Introductory Physics Seminar (1 credit)

Introduction to the physics major. Intended for all new physics students. Topics include: navigating the physics major, study skills, practice with written and oral presentations; history of physics, contemporary topics in physics, physics careers, developing math and computer skills, using units and dimensional analysis, order of magnitude estimation, and problem-solving practice. Field trips or occasional meetings outside of the regularly scheduled class time may be required. May be repeated for a maximum of 3 credits.

PHYS 210 Intermediate Mechanics (3 credits)

Prerequisite(s): PHYS 192 with a grade of C- or higher, and MATH 122 or AMAT 120 with a grade of C- or higher; Completion of MATH 221 or AMAT 220 strongly recommended. Intermediate-level overview of classical mechanics: kinematics, Newton's laws, impulse and momentum, statics, work and energy, oscillations, central force motion, non-inertial frames, introduction to Lagrange's and Hamilton's equations.

PHYS 220 Oscillations, Waves, and Optics (3 credits)

Prerequisite(s): PHYS 192 with a grade of C- or higher; and completion of MATH 122 or AMAT 120 with a grade of C- or higher; Completion of MATH 221 or AMAT 220 strongly recommended. Intermediate level treatment of oscillations, waves, and optics. Topics include simple harmonic oscillation including damping and resonance, coupled oscillators and normal modes, nonlinear oscillations, basic wave properties, traveling and standing waves, waves in media, dispersion relations, derivation of wave equations, geometric optics, diffraction and interference, Fourier analysis.

PHYS 230 Intermediate Physics Laboratory (4 credits)

Prerequisite(s): PHYS 192. Introduction to laboratory techniques. Topics include acquisition, recording, analysis, and interpretation of data; data fitting and error estimation. Labs are focused on fundamental experiments in classical mechanics, electricity and magnetism, and intermediate experiments in waves and optics. Students will learn basic principles of circuit design, the use of standard laboratory research equipment such as a signal generator and oscilloscope, as well as the basics of automated data acquisition.

PHYS 245 Fundamentals of Electronics (4 credits)

Prerequisite(s): PHYS 192 or PHYS 194. An introduction to the principles of electric circuits and basic components of electronics. Topics may include, Ohm's and Kirchhoff's laws, measuring basic circuit properties, RC and RLC circuits, using waveform generators and oscilloscopes, diodes, transistors, amplifiers.

PHYS 280 Astronomy for Physicists (4 credits)

Prerequisite(s): PHYS 191 or PHYS 193. An introduction to astronomy for physics majors. Traces the evolution of the universe from the Big Bang, through the formation of galaxies, stars, planets, and life. Additional topics include the nature of space and time, black holes and gravitational waves, cosmology, galaxy collisions and spiral structure, methods for observing the universe, understanding the night sky, overview of the solar system, exoplanets, and life in the universe. Labs include telescopic observations, spectroscopy, optics, and computer simulations. Contains more advanced material than PHYS 180. Field trips or occasional meetings outside of the regularly scheduled class time may be required. Meets the Graduation Writing Requirement for majors in Physics.

PHYS 300 Junior/Senior Physics Seminar (1 credit)

Prerequisite(s): PHYS 210 or PHYS 220. Selected topics related to physics and physics careers. These include: preparation for graduate school, industry, or teaching; alternative career pathways. Refining writing and presentation skills. Problem solving practice including numerical computation, order of magnitude estimation, advanced mathematical tips/tricks, and special topics not ordinarily covered in other physics courses. Seminars and readings on contemporary topics in physics. Field trips or occasional meetings outside of the regularly scheduled class time may be required. Meets the Graduation Writing Requirement for majors in Physics. May be repeated for a maximum of 3 credits.

PHYS 310 Advanced Mechanics (3 credits)

Prerequisite(s): PHYS 210 and PHYS 220. Advanced topics in classical mechanics including: generalized motion and transformations; Lagrange's and Hamilton's equations; oscillations; rigid body motion, wave propagation; nonlinear dynamics and chaos, perturbation theory, scattering theory, continuum mechanics. Meets the Graduation Writing Requirement for majors in Physics.

PHYS 320 Statistical and Thermal Physics (3 credits)

Prerequisite(s): PHYS 210 or PHYS 220. An introduction to thermodynamics and statistical physics. Topics include: laws of thermodynamics, entropy, heat engines, free energy, phase transformations, Maxwell-Boltzmann distribution, equipartition theorem, Fermi and Bose statistics, partition function, ideal gas law, and Ising model.

PHYS 325 Computational Physics (3 credits)

Prerequisite(s): MATH 221 or AMAT 220; and PHYS 191; and PHYS 192; and CSIT 111 or CSIT 104. This course applies computer techniques and numerical analysis to model physical systems. Topics include: basic programming structures, numerical error, plotting and manipulating data, finite differencing, numerical integration, numerical solution of ODEs and systems of equations, and Monte Carlo techniques. Simulation examples may include falling bodies, gravitational orbits, scattering, oscillations, electrical circuits, molecular dynamics, chaos, and quantum systems. Equivalent course PHYS 430 effective through Spring 2019.

PHYS 330 Advanced Physics Laboratory (4 credits)

Prerequisite(s): PHYS 230. Advanced laboratory techniques. Experiments in areas of atomic and nuclear physics, advanced optics, and electronics. Prior or concurrent enrollment in Modern Physics (PHYS 360) strongly recommended.

PHYS 340 Electricity and Magnetism (3 credits)

Prerequisite(s): PHYS 210 or PHYS 220; and MATH 222 may be taken as prerequisite or corequisite. Basic principles of electromagnetism: Coulomb's law and general techniques in electrostatics, currents and their associated magnetic field, electromagnetic induction and magnetic properties of materials. Foundations of Maxwell's equations. Equivalent course PHYS 240 effective through Spring 2019.

PHYS 341 Electronics and Digital Circuits (4 credits)

Prerequisite(s): PHYS 230. An introduction to fundamental principles of analog and digital circuits, semiconductor properties, operational amplifiers, circuit design and prototyping, filters, converters, power supplies, and logic devices.

PHYS 350 Modern Optics (4 credits)

Prerequisite(s): PHYS 210 or PHYS 220. Geometrical optics and ray transfer matrix analysis, Fourier optics, coherence, interference, holography, diffraction, light and matter interaction, nonlinear optics, Gaussian beams, optical resonators, principles and applications of lasers, elements of photonics. Meets the Graduation Writing Requirement for majors in Physics.

PHYS 360 Modern Physics (3 credits)

Prerequisite(s): PHYS 210 or PHYS 220. An overview of physics from the 20th century and onwards. Topics include: special relativity, quantization and elementary quantum mechanics, structure of the atom, and an introduction to particle/nuclear, condensed matter, and solid state physics. (Offered alternate years.) Equivalent course PHYS 460 effective through Spring 2019.

PHYS 368 Fluid Mechanics (3 credits)

Prerequisite(s): MATH 222 with a grade of C- or higher; and PHYS 210, PHYS 220, PHYS 377, MATH 325, or AMAT 350. Mechanics of continuous media, liquids and gases; stress, viscosity, Navier-Stokes and Euler equations, exact solutions, potential flow, circulation and vorticity, turbulence, dimensional analysis and asymptotic models, boundary layers, stability theory, and applications to industrial and environmental problems.

PHYS 377 Mathematical Physics (3 credits)

Prerequisite(s): MATH 222. Vector analysis, complex variables, ordinary and partial differential equations, matrices, Fourier analysis, special functions.

PHYS 380 Observational Astronomy (4 credits)

Prerequisite(s): PHYS 230 or PHYS 280. Observational techniques for the Moon, planets, satellites of other planets, asteroids, comets, stars, star clusters, and galaxies.

PHYS 399 Special Topics in Physics (1-4 credits)

Prerequisite(s): PHYS 210 or PHYS 220. Study of advanced topics in Physics. Topics will vary. May include a laboratory component. May be repeated for a maximum of 8 credits.

PHYS 451 Radiation and Medical Physics (3 credits)

Prerequisite(s): PHYS 330 or PHYS 360 may be taken as prerequisite or corequisite. This course covers the basics of radiation physics, including ultrasound, X-rays, and alpha, beta, and gamma radiation. It also deals with the application of concepts and methods from physics to the diagnosis and treatment of human disease. It introduces the physical principles and basic mathematical methods underlying the various models of medical testing, imaging, and treatment. These include computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), single-photon emission tomography (SPECT), and ultrasound. Covers nuclear physics and the interaction of radiation with biological matter with application to radiation therapy.

PHYS 452 Medical Physics Seminar (3 credits)

Prerequisite(s): PHYS 330 or PHYS 360 may be taken as prerequisites or corequisites. This is an in-field seminar conducted by expert practitioners at Mountinside Hospital with the supervision of an MSU faculty advisor. Examines the clinical and diagnostic applications of medical imaging methods (CT, MRI, and PET), the clinical applications of radiation therapy, and the clinical applications of ultrasound, lasers, and optical techniques. Includes on-site shadowing of doctors and professional medical personnel at local hospitals and visits to medical instrumentation companies.

PHYS 461 General Relativity (3 credits)

Prerequisite(s): PHYS 340 or PHYS 360 or PHYS 368 or MATH 368. An introduction to Einstein's geometric theory of gravity. Topics will include: special relativity, 4-vectors, the twin paradox, the metric tensor, non-Euclidean geometry, the equivalence principle, the gravitational redshift, geodesics, the Schwarzschild solution, and black holes.

PHYS 462 Nuclear Physics (4 credits)

Prerequisite(s): PHYS 360. Nuclear radiation; radioactive decay; detectors; nuclear spectroscopy and reactions; fission, fusion, reactors; and application of radioisotopes.

PHYS 464 Quantum Mechanics (3 credits)

Prerequisite(s): PHYS 320, PHYS 340 or PHYS 360. Schrodinger's wave equation, its application and interpretation; tunneling, quantized simple harmonic oscillator, angular momentum, the Hydrogen atom, Pauli exclusion principle; bra/ket notation, perturbation theory, and entanglement. (Offered alternate years.)

PHYS 470 Solid State Physics (3 credits)

Prerequisite(s): PHYS 360. Properties of solid state matter are developed from the quantum mechanics of atoms and molecules. (Not offered every year.)

PHYS 480 Astrophysics (3 credits)

Prerequisite(s): PHYS 320 or PHYS 340 or PHYS 360 or PHYS 368 or MATH 368. An introduction to gravity and stellar astrophysics. Topics include: overview of basic astrophysical concepts; solution to the gravitational-two body problem; tidal and 3-body interactions; applications to the solar system and exoplanets; radiation and radiation transport; stellar spectra and atmospheres; stellar structure, oscillation, and evolution.

PHYS 495 Research or Independent Study in Physics (1-4 credits)

Prerequisite(s): Departmental approval. Student coordinates with a faculty member on an appropriate topic of study. This might include a program of independent study based on a standard physics course, a literature exploration of a physics topic not normally covered in our course catalog, or (more commonly) research on a topic of joint interest between the student and faculty member (or approved research staff at an external institution). Research may be laboratory-based, computational, or theoretical. A written report or presentation is generally required. May be repeated twice for a maximum of 12 credits. Students are expected to contact the relevant faculty member in advance to determine availability and discuss appropriate topics.

PHYS 502 Physics for Middle Grades Teaching (4 credits)

Restriction(s): Restricted to majors in Elementary School with Subject Matter Specialization: Science 5-8 or program coordinator approval. To provide individuals interested in teaching middle school science with knowledge of the principles and applications in physics from a unified energy-based outlook, and how to present the laws of physics to the middle grades students. Emphasis will be placed on problem solving methods and the development of critical thinking skills. Equivalent course SCIM 502 effective through Summer 2019.

PHYS 519 Special Topics in Physics (3 credits)

Prerequisite(s): At least 12 semester hours in physics and departmental approval. Designed to acquaint the student with recent developments in physics and applications of physics. Examples of topic areas are astrophysics, laser applications, applications of quantum theory, solid state applications, and medical physics. May co-sit with an existing physics course. This is an elective requirement for the Teaching (MAT) with Certification in Physical Science degree program. May be repeated once for a maximum of 6 credits.