PHYSICS

Physics is the study of the most fundamental properties of matter and energy.

The Bachelor of Science in Physics has been designed with the recognition that a student might choose to concentrate in physics for a variety of reasons. In addition to meeting the needs of those planning to continue their physics education in graduate school, the program serves students planning to pursue technical careers immediately after graduation, those seeking to enter medical, dental or other professional schools, and those planning to earn certification as high school teachers.

After completing a core curriculum in physics and mathematics and an introduction to the life and other physical sciences, students have the opportunity to gain first-hand experience in basic and applied physics research. Most advanced students are able to participate in the research projects of faculty members during any of three University terms. Similar experiences may be arranged in hospital, industrial or government research facilities around the country.

The physics faculty have concentrated their efforts in quantum optics, astrophysics, biophysics, condensed matter physics, and statistical physics. Physics majors have worked in these areas and also on projects in the interdisciplinary application of physics in medicine and the environment.

Dearborn Discovery Core (General Education)

All students must satisfy the University's Dearborn Discovery Core requirements (https://catalog.umd.umich.edu/undergraduate/gen_ed_ddc/), in addition to the requirements for the major. Students must also complete all CASL Degree Requirements. (https://catalog.umd.umich.edu/undergraduate/college-arts-sciences-letters/)

Pre-Major Requirements

A solid background in mathematics is essential to success in any scientific discipline. Incoming students who intend to major in physics should have completed at least three years of high school mathematics. First-year students should plan to enroll in MATH 105, MATH 115 or MATH 116 based on the results of their math placement tests. PHYS 125/ PHYS 125L or PHYS 150 /PHYS 150L and PHYS 126 / PHYS 126Lor PHYS 151 / PHYS 151L are prerequisites to all other physics courses. Students should complete these courses as soon as possible.

Code	Title	Credit Hours
Select from one of the following PHYS two courses sequences: (PHYS 150/PHYS 150L & PHYS 151/PHYS 151L **or** PHYS 125/ PHYS 125L & PHYS 126/PHYS 126L):		8
PHYS 150 & 150L	General Physics I and General Physics I Lab/Dis	
PHYS 151 & 151L	General Physics II and General Physics II Lab/Dis	
OR		
PHYS 125 & 125L	Introductory Physics I and Introductory Physics I Lab/Dis	
PHYS 126 & 126L	Introductory Physics II and Intro Physics II Lab/Dis	
PHYS 260	Instrumentation and Computing for Physicists	4
CHEM 134	General Chemistry IA	4
MATH 115	Calculus I	4
MATH 116	Calculus II	4
MATH 215	Calculus III	4
MATH 228	Diff Eqns with Linear Algebra	4
Select one additional science course from the following:		4
CHEM 136	General Chemistry IIA	
BIOL 130	Intro Org and Environ Biology	
BIOL 140	Intro Molec & Cellular Biology	
GEOL 118	Physical Geology	
Total Credit Hours		**36**

Major Requirements

Code	Title	Credit Hours
Required Courses		
PHYS 305	Quantum Mechanics I	4
PHYS 370	Mathematical Physics	4
PHYS 401	Classical Mechanics and Relativity	4
PHYS 403	Electricity and Magnetism	4
PHYS 407	Thermal and Statistical Physics	4
PHYS 453	Quantum Mechanics II	4
PHYS 460	Advanced Physics Laboratory	4
Select four additional credit hours of lecture courses in physics and/or astronomy, from the following:		4
PHYS 302	Biomedical Physics	
PHYS 314	Computational Physics	
PHYS 320	Environmental Physics	
PHYS 390	Current Topics in Physics	
PHYS 405	Optics	
PHYS 416	Biological Physics	
PHYS 422	Biomedical Imaging	
ASTR 301	Astrophysical Concepts	
ASTR 330	The Cosmic Distance Scale	
ASTR 361	Observational Techniques	
ASTR 390	Topics in Astronomy	
ASTR 421	Stellar Astrophysics	
ASTR 445	Galaxies and Cosmology	
Select three or four additional credit hours of research or laboratory courses, from the following:		3-4
PHYS 460	Advanced Physics Laboratory (may be repeated for credit)	
PHYS 495	Off-Campus Research	
PHYS 498	Directed Studies in Physics	
PHYS 499	Laboratory Studies in Physics	
ASTR 495	Off-Campus Research in Astronomy	
ASTR 498	Directed Studies in Astronomy	
ASTR 499	Research in Astronomy	
Total Credit Hours		**35-36**

Notes:

1. At least 17 of the 35-36 Major Requirement credit hours in PHYS must be elected at UM-Dearborn.
2. A maximum of 8 credit hours of independent study/research in any Department of Natural Sciences discipline may count towards the 120 credit hours required to graduate.

Minor or Integrative Studies Concentration Requirements

A minor or concentration consists of 12 credit hours of upper-level courses in physics (PHYS).

- A minimum GPA of 2.0 is required for the minor/concentration. The GPA is based on all coursework required within the minor (excluding prerequisites).
- The use of transfer credit, field placements, internships, seminars, S/E graded courses, and independent study/research courses is limited to 3 credits in a 12 credit hour minor/concentration and 6 credits in a 15 credit hour and above minor/concentration.
- Courses within a minor/concentration cannot be taken as Pass/Fail (P/F).
- Minors requiring 12 credits may share one course with a major. Minors requiring 15 credits or more may share two courses with a major. This does not apply to concentrations for the Integrative Studies major.

Learning Goals

Overview

- Understand physics as a way of thinking, including its physical, conceptual, analytical, philosophical, and numerical modes of thought.
- Understand how the different fields of physics are organized into a single whole. Understand the connection between the parts and the relation between theory and experiment.
- Know and appreciate the historical evolution of physics and natural philosophy.
- Understand the role of physics in science, society, and technology.

Principles

Understand the fundamental principles (laws, postulates, axioms) from which the entire subject of physics logically unfolds, including: Dynamical Laws, Statistical Laws, Fields and Quanta, Conservation Laws, and Spacetime Laws.

Applications

Demonstrate the ability to apply the fundamental principles learned in the core physics courses (classical mechanics, electricity and magnetism, statistical and thermal physics, quantum mechanics) to a variety of systems and processes within physics, and also at the interface of physics and the other sciences, including:

- Atomic, Molecular, and Optical Physics
- Statistical and Condensed Matter Physics
- Astronomy and Astrophysics
- Mathematical and Computational Physics
- Nuclear and Particle Physics
- Biological, Chemical, and Environmental Physics
- Physics Education

Theory

- Understand and utilize the mathematical tools commonly used by physicists, including calculus, differential equations, linear algebra, Fourier analysis, and numerical methods.
- Understand and appreciate the guiding principles used in formulating theories of the physical world, including linearity, symmetry, simplicity, and universality.
- Develop the skills, or modes of thinking, that characterize the “art” of theoretical physics, including modeling, estimation, approximation, dimensional analysis, and limiting cases.

Experiment

- Demonstrate the ability to perform standard experiments and reach valid conclusions.
- Demonstrate the ability to design the experimental procedure and the method of analysis for a new experiment and to carry it to a successful conclusion.
- Understand, utilize, design, and construct scientific instruments and data-collection systems for the experimental study of physics.
- Know how to use a variety of techniques to organize, display, and analyze experimental data.

Communication

- Work effectively in groups to solve problems, perform experiments, and conduct research.
- Write acceptable laboratory reports, scientific essays, and journal articles.
- Make effective poster and oral presentations on technical subjects.

PHYS 125 Introductory Physics I 3 Credit Hours
Part I of a non-calculus, introductory, survey of physics. The concepts of physics are presented with an emphasis on the methods of solving physical problems. Topics are drawn from mechanics, waves, and thermal physics. This course and PHYS 126 are normally taken by students in biomedical physics, biological science, preprofessional and computer science programs. Three hours lecture, one hour discussion, three hours laboratory. (F, W, S) (F, W, S).
Prerequisite(s): MATH 105* or MATH 113* or MATH 115* or Math Placement with a score of 113
Corequisite(s): PHYS 125L

PHYS 126 Introductory Physics II 3 Credit Hours
A continuation of PHYS 125. Topics are drawn from electricity and magnetism, optics, and modern physics. Three hours lecture, one hour discussion, three hours laboratory. (F, W, S) (F, W, S).
Prerequisite(s): PHYS 125 or PHYS 150
Corequisite(s): PHYS 126L

PHYS 150 General Physics I 3 Credit Hours
Part I of an integrated, two-semester, calculus-based treatment of physics, with emphasis on the solution of physical problems through the understanding of a few basic concepts. Topics are drawn from mechanics. This course and PHYS 151 are normally taken by concentrators in physics, biomedical physics, chemistry, biochemistry, mathematics, and engineering. Three hours lecture, one hour discussion, three hours laboratory. (F, W, S) (F, W, S).
Prerequisite(s): MATH 115* or Math Placement with a score of 116
Corequisite(s): PHYS 150L

PHYS 151 General Physics II 3 Credit Hours
A continuation of PHYS 150. Topics are drawn from electricity and magnetism, and optics. Three hours lecture, one hour discussion, three hours laboratory. (F, W, S) (F, W, S).
Prerequisite(s): (PHYS 125 or PHYS 150) and MATH 116*
Corequisite(s): PHYS 151L

PHYS 260 Instrumentation and Computing for Physicists 4 Credit Hours
An introduction to electronic and computational tools used in experimental physics. Techniques of physical measurement using sensors will be explored, including the use of high-level electronic instrumentation such as the oscilloscope and digital multimeter, as well as component-level analog and digital electronics for signal conditioning and computer data acquisition. Computational skills will be developed to interface computers with experiments, to program microcontrollers, and to visually and analyze data. Students will complete individual projects. Three hours lecture, four hours laboratory. Every third semester. (F, W).
Prerequisite(s): PHYS 126* or PHYS 151*

PHYS 302 Biomedical Physics 4 Credit Hours
An interdisciplinary course that combines the principles of physics with applications in medicine and biology. The course provides an overview of the fundamental physical principles and techniques used in biomedical physics. Topics include discussions of the physical principles underlying medical imaging techniques (magnetic resonance imaging, ultrasound), diagnostic tools, therapeutic applications, biomechanical systems and functioning of the human body. Four hours lecture. Every fourth semester. (F, W).
Prerequisite(s): PHYS 126 or PHYS 151

PHYS 305 Quantum Mechanics I 4 Credit Hours
Reviews experiments demonstrating the atomic nature of matter, wave-particle duality, the uncertainty principle, the Schrödinger wave equation, properties of the electron, the nuclear atom, spin, atomic and molecular structure and spectra, statistical physics, solid state physics, and nuclear physics including nuclear structure, radioactive decay, and fission. Includes an introduction to the special theory of relativity. Four hours lecture. (Every third semester) (F, W).
Prerequisite(s): (PHYS 126 or PHYS 151) and (MATH 116 or Math Placement with a score of 215)

PHYS 314 Computational Physics 4 Credit Hours
An introduction to numerical and computational techniques in physics and astronomy. Topics include an introduction to scientific computing, fitting data to a model, visualizing results, plotting, error analysis, and writing software to solve physical problems. Applications will be selected from a variety of subfields, including: biomedical physics, classical mechanics, statistical physics, electromagnetism, astrophysics, and chaos. Four hours lecture. (Every fourth semester) (F, W).
Prerequisite(s): (PHYS 126 or PHYS 151) and (MATH 205* or MATH 215*)

PHYS 320 Environmental Physics 4 Credit Hours
A survey of the applications of physical principles to the environment, and to the conversion, transfer, and use of energy. Introductory discussion of thermodynamics and radiative transfer, with applications to planetary climate, meteorology, the greenhouse effect, and thermal pollution. Four hours lecture. (OC) (OC).
Prerequisite(s): PHYS 126 or PHYS 151

PHYS 360 Instrumentation for Scientists 4 Credit Hours
An introduction to the principles of electronic instrumentation used in scientific research. Methods of converting physical measurements into electronic signals by means of electrical circuits, transistors, digital and analog integrated circuits will be discussed. Digital computers as general purpose laboratory instruments will be explored. Students will complete individual projects. Three hours lecture, four hours laboratory. (F).
Prerequisite(s): PHYS 126 or PHYS 151

PHYS 370 Mathematical Physics 4 Credit Hours
As introduction to those mathematical methods that are widely used in understanding the physical phenomena exhibited by nature. Topics include vector analysis, linear algebra, complex variables, Fourier analysis, and differential equations. Emphasis is on the application of these techniques to physical problems of interest to students in mathematics, engineering, and the physical sciences. Four hours lecture. (Every fourth semester). (F, W).
Prerequisite(s): (MATH 205 or MATH 215 or Math Placement with a score of 215) and (PHYS 126 or PHYS 151)

PHYS 390 Current Topics in Physics 4 Credit Hours
A lecture course in a topic of current interest in physics. Topics vary and are announced in the current Schedule of Classes. Four hours lecture. (OC).
Prerequisite(s): PHYS 305*

PHYS 401 Classical Mechanics and Relativity 4 Credit Hours
A study of the classical physics of the motions of single particles, systems of particles, and rigid bodies. Topics include central force laws and planetary motion, collisions and scattering, rigid body motion, oscillations, Lagrange's equations, Hamilton's principle, and special relativity. Four hours lecture. (Every fourth semester) (F, W).
Prerequisite(s): (MATH 205 or MATH 215 or Math Placement with a score of 215) and (PHYS 126 or PHYS 151)

PHYS 403 Electricity and Magnetism 4 Credit Hours
This course integrates the study of electricity and magnetism with optics, exploring physical principles, phenomena, and applications. It builds on foundational concepts, covering electric and magnetic fields, electromagnetic waves, and light-matter interactions. Emphasizing mathematical foundations, students gain a rigorous understanding of Maxwell's equations, wave propagation, and optical phenomena. Through theoretical analysis and experimental applications, students develop comprehensive knowledge to tackle complex problems in scientific research and technology. Four hours lecture. (Every fourth semester) (F, W).
Prerequisite(s): (MATH 205 or MATH 215 or Math Placement with a score of 215) and (PHYS 126 or PHYS 151)

PHYS 405 Optics 4 Credit Hours
An upper-level physics course that explores advanced principles and applications of optics, for students in engineering, mathematics, and the physical sciences. Building on the foundations of Maxwell's equations, topics of discussion will include geometrical optics, polarization, fiber optics, interference, and Fraunhofer and Fresnel diffraction. Depending on students' needs and interests, additional topics may include coherence, interference, laser optics, Fourier optics, and holography. Four hours lecture. (OC) (OC).
Prerequisite(s): (MATH 205 or Math Placement with a score of 215 or MATH 215) and (PHYS 126 or PHYS 151)

PHYS 407 Thermal and Statistical Physics 4 Credit Hours
A study of thermodynamic phenomena using the methods of statistical mechanics. Designed for engineering students and concentrators in mathematics and the physical sciences; extensive application is made to physical, chemical, and biological systems and phenomena, including solids, liquids, gases, paramagnets, thermal radiation, DNA, hemoglobin, semiconductors, heat engines, chemical reactions, and phase transitions. Four hours lecture. (Every fourth semester) (F, W).
Prerequisite(s): (MATH 205 or MATH 215) and (PHYS 126 or PHYS 151)

PHYS 416 Biological Physics 4 Credit Hours
A course based on the methodology of physics with particular emphasis on the applications of theoretical models and experimental methods to biological objects and systems. Topics will include physical understanding of a wide range of biological phenomena, examples of which may include cytoskeletal mechanics, functioning of ion channels, packaging and replication of nucleic acids, pattern formation, and cellular motility. Four hours lecture. (Every fourth semester) (F, W).
Prerequisite(s): MATH 116 and (PHYS 126 or PHYS 151)

PHYS 421 Astrophysics 3 Credit Hours
A calculus-based introduction to several major areas of modern astrophysics for students concentrating in the physical sciences, mathematics, and engineering. Topics to be covered include observable properties of stars and star systems, stellar structure and evolution, binary systems and galactic x-ray sources, galaxies and quasars, and cosmology. Three hours lecture. (AY).
Prerequisite(s): (PHYS 305 or ASTR 301 or ASTR 330) and (MATH 205 or MATH 215)

PHYS 422 Biomedical Imaging 4 Credit Hours
Biomedical imaging technologies provide noninvasive ways to capture the structure and function of the human body for the diagnosis and treatment of disease or physiological abnormality. The major goal of this course is to introduce the fundamentals of microscopy imaging techniques, data visualization, image processing, and analysis with hands-on lab experience. Three hours lecture, three hours laboratory. Every fourth semester. (F, W).
Prerequisite(s): PHYS 126 or PHYS 151

PHYS 453 Quantum Mechanics II 4 Credit Hours
This course explores the fundamental principles and advanced concepts of quantum mechanics. Students deepen their understanding of mathematical formalism, including linear algebra and Dirac notation. Topics include wave-particle duality, the time-dependent Schrodinger equation, quantum mechanics in three dimensions, identical particles, and perturbation theory. Advanced topics may include quantum entanglement, superposition, and information theory along with applications such as quantum computation and communication. Emphasis is placed on theoretical comprehension, problem-solving, and connecting theory to practical implementation. Four hours lecture. (Every fourth semester) (F, W).
Prerequisite(s): (PHYS 126 or PHYS 151) and PHYS 305 and MATH 228

PHYS 460 Advanced Physics Laboratory 4 Credit Hours
Experiments in both classical and modern physics using contemporary techniques. Commercial apparatus is used in several experiments. Advanced students are encouraged to initiate and conduct their own experiments. Instruction in the planning of experiments and the presentation of oral and written reports is included. Two hours lecture, six hours laboratory. Course may be repeated for credit. (Every third semester) (F, W).
Prerequisite(s): PHYS 305* and PHYS 260

PHYS 495 Off-Campus Research 1 to 4 Credit Hours
Participation in ongoing experimental research at an off-campus laboratory. Assignments made by cooperative or internship agreement between the research laboratory, the student, and the physics concentration advisor. Course may be repeated for credit. Three to twelve hours laboratory. Permission of concentration advisor. (F, W, S).

PHYS 498 Directed Studies in Physics 1 to 4 Credit Hours
Special topics in physics chosen by agreement between student and instructor. Course may be repeated for credit. Permission of instructor. (F,W,S).

PHYS 499 Laboratory Studies in Physics 1 to 4 Credit Hours
Experimental studies in physics selected by agreement between student and instructor. Three to twelve hours laboratory. Course may be repeated for credit. Permission of instructor. (F, W, S).

*An asterisk denotes that a course may be taken concurrently.

Frequency of Offering

The following abbreviations are used to denote the frequency of offering: (F) fall term; (W) winter term; (S) summer term; (F, W) fall and winter terms; (YR) once a year; (AY) alternating years; (OC) offered occasionally