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 in the area.

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

In addition to the major requirements, students must complete all CASL Degree Requirements (http://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 150 and PHYS 151 are prerequisites to all other physics courses. Students should complete these courses as soon as possible.

Code	Title	Credit Hours
CHEM 134	General Chemistry IA	4
PHYS 150	General Physics I	4
PHYS 151	General Physics II	4
MATH 115 & MATH 116 & MATH 215	Calculus I and Calculus II and Calculus III	12
MATH 228	Diff Eqns with Linear Algebra	4
Select two additional science courses from the following:		8
CHEM 136	General Chemistry IIA	
BIOL 130	Intro Org and Environ Biology	
or BIOL 140	Intro Molec & Cellular Biology	
GEOL 118	Physical Geology	
Total Credit Hours		**36**

Major Requirements

Code	Title	Credit Hours
Required Courses		
PHYS 305	Contemporary Physics	3
PHYS 360	Instrumentation for Scientists	4
PHYS 401	Mechanics	3
PHYS 403	Electricity and Magnetism	3
PHYS 406	Thermal and Statistical Physic	3
PHYS 453	Quantum Mechanics	3
PHYS 460	Advanced Physics Laboratory	3
Select six additional credit hours of lecture courses in astronomy and/or physics, chosen from (only one course can be astronomy (ASTR)):		6
ASTR 301	Astrophysical Concepts	
ASTR 330	The Cosmic Distance Scale	
ASTR 361	Observational Techniques	
ASTR 390	Topics in Astronomy	
ASTR/PHYS 421	Stellar Astrophysics	
ASTR 445	Galaxies and Cosmology	
PHYS 314	Computational Physics	
PHYS 320	Environmental Physics	
PHYS 370	Intro to Mathematical Physics	
PHYS 390	Current Topics in Physics	
PHYS 405	Optics	
PHYS 416	Biological Physics	
PHYS 457	Atomic and Nuclear Physics	
PHYS 463	Solid State Physics	
Select three additional credit hours of laboratory/research courses, selected from:		3
PHYS 460	Advanced Physics Laboratory (may be repeated for credit)	
PHYS 495	Off-Campus Research	
PHYS 499	Laboratory Studies in Physics	
Cognates		
Students must complete at least six additional credit hours in upper-level cognate courses selected from: ASTR, BIOL, BCHM, CHEM, ESCI, ENST, GEOL, MICR, NSCI, MATH (excluding 385, 386, 387), STAT, BENG, CIS, ECE, ENGR, IMSE, ME or other subject areas intimately related to physics and approved by the physics faculty advisor by Petition. [1]		6
Total Credit Hours		**37**

[1] Courses leading to knowledge of computer programming in languages such as Fortran, C++, or JAVA are particularly recommended.

Notes:

1. A maximum of 44 credit hours of PHYS may count in the 120 hours required to graduate.
2. At least 12 of the 31 upper level credit hours in PHYS must be elected at UM-Dearborn.

3. A maximum of 6 credit hours of independent study/research in any Dept. 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).
- A minimum of 9 credits must be completed at UM-Dearborn for a 12 credit minor/concentration.
- A minimum of 12 credits must be completed at UM-Dearborn for a 15 or more credit minor/concentration.
- Courses within a minor/concentration cannot be taken as Pass/Fail (P/F).
- Only 3 credit hours of independent study or internship may be used to fulfill the requirements for a 12 credit hour minor/concentration. Only 6 credit hours of such credit may be used in a 15 or more credit hour minor/concentration.
- 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 100 Perspectives in Physics 3 Credit Hours
An introductory look at the concepts and methods of physics as well as the role of physics in society today. Examines some of the problems facing physicists and the ways they go about tackling them. Problem solving includes the use of mathematics in physical situations. The course is designed for non-concentrators interested in physics. Three hours lecture. (S).

PHYS 125 Introductory Physics I 4 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 biological science, preprofessional and computer science programs. Three hours lecture, one hour discussion, three hours laboratory. (F).
Prerequisite(s): MATH 105* or Mathematics Placement with a score of 113
Corequisite(s): PHYS 125L

PHYS 126 Introductory Physics II 4 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. (W).
Prerequisite(s): PHYS 125 or PHYS 150
Corequisite(s): PHYS 126L

PHYS 150 General Physics I 4 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, chemistry, biochemistry, mathematics, and engineering. Three hours lecture, one hour discussion, three hours laboratory. (F,W).
Prerequisite(s): MATH 115* or Mathematics Placement with a score of 116
Corequisite(s): PHYS 150L

PHYS 151 General Physics II 4 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).
Prerequisite(s): PHYS 150 and (MATH 116* or Mathematics Placement with a score of 215)
Corequisite(s): PHYS 151L

PHYS 305 Contemporary Physics 3 Credit Hours
An introduction to contemporary topics in physics of interest to science, mathematics and engineering students. Topics include relativity, and quantum mechanics and their applications to atoms, molecules, nuclei, solid state phenomena, and cosmology. Three hours lecture. (W).
Prerequisite(s): (PHYS 126 or PHYS 151) and (MATH 116 or Mathematics Placement with a score of 215)

PHYS 314 Computational Physics 3 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: classical mechanics, statistical physics, quantum physics, electromagnetism, chaos, biophysics, and astrophysics. Three hours lecture.
Prerequisite(s): PHYS 151 and (MATH 205* or MATH 215*)

PHYS 320 Environmental Physics 3 Credit Hours
A survey of the applications of physical principles to the environment, and to the conversion, transfer, and use of energy. Problems of transportation, meteorology, and thermal pollution are included. Three hours lecture. (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 Intro to Mathematical Physics 3 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. Three hours lecture. (AY).
Prerequisite(s): (MATH 205 or MATH 215 or Mathematics Placement with a score of 215) and PHYS 151

PHYS 390 Current Topics in Physics 3 Credit Hours
A lecture course in a topic of current interest in physics. Topics vary and are announced in the current Schedule of Classes. Three hours lecture. (OC).
Prerequisite(s): PHYS 305*

PHYS 401 Mechanics 3 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, and Hamilton's principle. Three hours lecture. (F).
Prerequisite(s): (MATH 205 or MATH 215 or Mathematics Placement with a score of 215) and PHYS 151

PHYS 403 Electricity and Magnetism 3 Credit Hours
The study of electrostatics, magnetostatics and electrodynamics using Maxwell's equations. Of interest to engineers and physical scientists, the course focuses on the logical development of Maxwell's equations from experimental laws and on their application to electromagnetic phenomena. Three hours lecture. (W).
Prerequisite(s): (MATH 205 or MATH 215 or Mathematics Placement with a score of 215) and PHYS 151

PHYS 405 Optics 3 Credit Hours
An introduction to wave and ray optics for students in engineering, mathematics, and the physical sciences. Topics of discussion include reflection and refraction at dielectric surfaces, lenses and mirrors, fiber optics, polarization, interference, and Fraunhofer and Fresnel diffraction. Additional material on coherence, Fourier optics and spatial filtering, and holography is presented as dictated by students' needs and interests, and as time permits. Three hours lecture. (AY).
Prerequisite(s): (MATH 205 or Mathematics Placement with a score of 215 or MATH 215) and PHYS 151

PHYS 406 Thermal and Statistical Physic 3 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. Three hours lecture. (F).
Prerequisite(s): (MATH 205 or MATH 215 or Mathematics Placement with a score of 215) and PHYS 151

PHYS 416 Biological Physics 3 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 may include bioelectricity, membranes, polymers, and physical chemistry of macromolecules. Three hours lecture. (OC).
Prerequisite(s): MATH 205 or (MATH 215 and 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 453 Quantum Mechanics 3 Credit Hours
Concepts of quantum mechanics with applications of the Schrodinger wave equation to the simpler atoms, molecules, and nuclei. Topics of current interest to physicists, chemists, and biologists are discussed. Three hours lecture. (F).
Prerequisite(s): PHYS 305 and MATH 228

PHYS 457 Atomic and Nuclear Physics 3 Credit Hours
Topics in modern atomic physics such as optical and radio-frequency spectroscopy and scattering of atoms and electrons are considered. An introduction to nuclear physics, including nuclear interactions and structure, radioactive decay, fission, and fusion. Three hours lecture. (AY).
Prerequisite(s): (MATH 205 or MATH 215 or Mathematics Placement with a score of 215) and PHYS 305

PHYS 460 Advanced Physics Laboratory 3 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. One hour recitation, six hours laboratory. Course may be repeated for credit. (W).
Prerequisite(s): PHYS 305* and PHYS 360

PHYS 463 Solid State Physics 3 Credit Hours
A study of the structure and properties of the solid state of matter with emphasis on crystalline solids, crystal structures, lattice dynamics, electrons in metals and semiconductors, and dielectric and magnetic properties of solids. Three hours lecture. (AY).
Prerequisite(s): (MATH 205 or MATH 215 or Mathematics Placement with a score of 215) and PHYS 305

PHYS 490 Topics in Physics 1 to 3 Credit Hours
A lecture course in a topic of current interest in physics. Topics vary and are announced in the current Schedule of Classes. One to three hours lecture. (OC).

PHYS 495 Off-Campus Research 1 to 3 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. Four to twelve hours laboratory. Permission of concentration advisor. (F,W,S).

PHYS 497 Seminar in Physics 1 to 3 Credit Hours
Current topics from various areas in pure and applied physics are reported upon by students, faculty, and guest lecturers. Topics presented will vary from year to year. Course may be repeated for credit. One to three hours seminar. (W).

PHYS 498 Directed Studies in Physics 1 to 3 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 3 Credit Hours
Experimental studies in physics selected by agreement between student and instructor. Four 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