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.

Please visit the Physics (https://umdearborn.edu/casl/undergraduate-programs/areas-study/physics-and-astronomy) webpage for more information.

Dearborn Discovery Core Requirement

The minimum GPA for the program is 2.0. In addition, the DDC permits any approved course to satisfy up to three credit hours within three different categories. Please see the General Education Program: The Dearborn Discovery Core (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core) section for additional information.

Foundational Studies

Written and Oral Communication (GEWO) – 6 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gewo)

Upper Level Writing Intensive (GEWI) – 3 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gewi)

Quantitative Thinking and Problem Solving (GEQT) – 3 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#geqt)

Critical and Creative Thinking (GECC) – 3 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gecc)

Areas of Inquiry

Natural Science (GENS) – 7 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gens)

• Lecture/Lab Science Course

• Additional Science Course

Social and Behavioral Analysis (GESB) – 9 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gesb)

Humanities and the Arts (GEHA) – 6 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#geha)

Intersections (GEIN) – 6 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gein)

Capstone

Capstone (GECE) – 3 Credits (http://catalog.umd.umich.edu/undergraduate/general-information/general-education-program-dearborn-discovery-core/#gece)

Foreign Language Requirement

Complete a two-semester beginning language sequence.

Ancient Greek I and II MCL 105 and MCL 106
Arabic I and II ARBC 101 and ARBC 102
Armenian I and II MCL 111 and MCL 112
French I and II FREN 101 and FREN 102
German I and II GER 101 and GER 102
Latin I and II LAT 101 and LAT 102
Spanish I and II SPAN 101 and SPAN 102
Chinese I and II CHIN 101 and CHIN 102

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.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 134</td>
<td>General Chemistry IA</td>
<td>4</td>
</tr>
<tr>
<td>or CHEM 144</td>
<td>General Chemistry IB</td>
<td></td>
</tr>
<tr>
<td>PHYS 150</td>
<td>General Physics I</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 151</td>
<td>General Physics II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 115</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>&amp; MATH 116</td>
<td>and Calculus II</td>
<td></td>
</tr>
<tr>
<td>&amp; MATH 215</td>
<td>and Calculus III</td>
<td></td>
</tr>
<tr>
<td>MATH 216</td>
<td>Intro to Diff Equations</td>
<td>3-4</td>
</tr>
<tr>
<td>or MATH 228</td>
<td>Diff Eqns with Linear Algebra</td>
<td></td>
</tr>
<tr>
<td>MATH 227</td>
<td>Introduction to Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>Select two additional science courses from the following:</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>CHEM 136</td>
<td>General Chemistry IA</td>
<td></td>
</tr>
<tr>
<td>or CHEM 144</td>
<td>General Chemistry II</td>
<td></td>
</tr>
<tr>
<td>BIOL 130</td>
<td>Intro Org and Environ Biology</td>
<td></td>
</tr>
<tr>
<td>or BIOL 140</td>
<td>Intro Molec &amp; Cellular Biology</td>
<td></td>
</tr>
</tbody>
</table>
**Major Requirements**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 305</td>
<td>Contemporary Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 360</td>
<td>Instrumentation for Scientists</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 401</td>
<td>Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 403</td>
<td>Electricity and Magnetism</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 406</td>
<td>Thermal and Statistical Physic</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 453</td>
<td>Quantum Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 460</td>
<td>Advanced Physics Laboratory</td>
<td>3</td>
</tr>
</tbody>
</table>

Select six additional credit hours of lecture courses in astronomy and/or physics, chosen from (only one course can be astronomy (ASTR)):

- 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:

- 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

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.
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 MPLS 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 MPLS 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 MPLS 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 MATH 215) or MPLS with a score of 215 and PHYS 151

PHYS 406  Thermal and Statistical Physics  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 and PHYS 151 or MPLS with a score of 215)

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 216

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 MPLS with a score of 215) and PHYS 305

PHYS 459  Advanced Physics Laboratory  2 Credit Hours
Experimental techniques will be introduced with emphasis on modern physical measurements. Pre-developed apparatus will be available for an implementation of several standard experiments. General facilities will also be available for selected experiments designed by the students to meet individual needs. Instruction in the planning of experiments and the organization and presentation of results will be included. Eight hours laboratory. (Offered Fall Term only.)
Prerequisite(s): PHYS 305 and PHYS 403
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 MPLS 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