Physics and Astrophysics (Phys)

http://www.arts-sciences.und.edu/physics-astrophysics

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The Department of Physics and Astrophysics offers a B.S. degree, a five-year B.S.-M.S. degree and a minor in physics. Majors may elect to earn a general physics degree or to specialize in one of four tracks. The five physics degree options are:

1. No specialization
2. Applied Physics Track
3. Astrophysics Track
4. Computers in Physics Track
5. Materials Science Track

B.S. with Major in Physics

Required 125 credits (36 of which must be numbered 300 or above and 60 of which must be from a 4-year institution) including:

I. Essential Studies Requirements (see University ES guidelines and course listings).

II. The Following Curriculum:

Each track leads to a Bachelor of Science with Major in Physics, awarded through the College of Arts and Sciences. A total of 125 credits is required for graduation. In addition to other University Graduation Requirements and the courses specified for one of the five options listed below, all Physics majors must complete successfully the following set of core courses:

PHYS 251	University Physics I	4
PHYS 252	University Physics II	4
PHYS 253	University Physics III	4
PHYS 317 & PHYS 318	Mechanics I and Mechanics II	6
PHYS 324	Thermal Physics	3
PHYS 325	Optics	3
PHYS 325L	Optics Laboratory	1
PHYS 327 & PHYS 328	Electricity and Magnetism I and Electricity and Magnetism II	6
PHYS 415	Undergrad Research Experience	3
PHYS 428	Advanced Physics Laboratory	2
PHYS 431 & PHYS 432	Quantum Mechanics I and Quantum Mechanics II	6
CHEM 121 & CHEM 122	General Chemistry I and General Chemistry II	6
CHEM 121L & CHEM 122L	General Chemistry I Laboratory and General Chemistry II Laboratory	2
MATH 165 & MATH 166 & MATH 265	Calculus I and Calculus II and Calculus III	12
MATH 266	Elementary Differential Equations	3
MATH 352	Introduction to Partial Differential Equations	3
MATH 207	Introduction to Linear Algebra	2
Total Credits		70

To provide proper advisement, the Department of Physics and Astrophysics requires its majors to meet with their physics adviser prior to registration each semester. This ensures each student is enrolled in appropriate classes and helps the department schedule certain courses in a timely manner. A hold is placed on registration for physics majors until this advisement session takes place. It is the student's responsibility to schedule the advisement session.

Beyond completion of the core listed above and the general education requirements, all physics majors must complete one of the following options together with additional electives for a total of 125 credits.

I. General Physics option: This is a general physics degree offering maximum flexibility. It is appropriate for students who may seek advanced degrees, for instance, or who are interested in medical school. Beyond the core, the student must complete an additional 9 credits of Physics numbered above 300. No more than 3 credits of these 9 may be in PHYS 492 Special Problems.

II. Applied Physics track: This choice will provide interdisciplinary training in applied physics and applied electronics with emphasis on instrumentation and measurement technique. The aim is to prepare the student to work as part of a research team in an industrial, government or academic setting. In addition to the core, the student must complete:

EE 206	Circuit Analysis	3
EE 321	Electronics I	3
EE 308		2
PHYS 402	Computers in Physics	3
EE 452	Embedded Systems	3
Total Credits		14

In addition, students electing the applied physics track should select an instrumentation project as a means of satisfying the research core requirement, PHYS 415 Undergrad Research Experience.

III. Astrophysics track: This option is for students with special interest in astronomy, astrophysics, space exploration or aerospace applications. The following are required.

PHYS 110	Introductory Astronomy	3
PHYS 110L	Introductory Astronomy Lab	1
PHYS 434	Nuclear Physics	3
PHYS 460	Introduction to Astrophysics	3
PHYS 461	Introduction to Astrophysics II	3
Total Credits		13

To satisfy the research requirement, PHYS 415 Undergrad Research Experience, students in the astrophysics track should select an approved astrophysics project.

IV. Computers in Physics track: This choice provides extensive experience using computers for running experiments, analyzing data, doing computer simulations and calculations in physics. The student should be prepared to learn programming languages. The following are required.

CSCI 160	Computer Science I	4
CSCI 161	Computer Science II	4
PHYS 402	Computers in Physics	3
Total Credits		11

For the Computers in Physics track, students should seek out computational research projects for PHYS 415 Undergrad Research Experience, or laboratory projects involving computer instrumentation

V. Materials Science track: This option provides the strongest foundation in solid state and materials science. Required are:

PHYS 320	Introduction to Materials Science	3
PHYS 420	Advanced Topics in Materials Science	3
PHYS 437	Introductory Solid State Physics	3
Total Credits		9

Students in this track should select approved research projects in materials science as a means of satisfying the PHYS 415 Undergrad Research Experience requirement.

Five-year B.S.-M.S. Degree in Physics

Five-year B.S.-M.S. Degree Program in Physics

The program will **use only the existing courses** in the Department of Physics and Astrophysics, Department of Mathematics, and Department of Chemistry.

The program course requirements include the following courses:

PHYS 251C	University Physics I	3
PHYS 251CL	University Physics I Lab	1
PHYS 252C	University Physics II	3
PHYS 252CL	University Physics II Lab	1
PHYS 253C	University Physics III	3
PHYS 253CL	University Physics III Lab	1
PHYS 317	Mechanics I	3
PHYS 318	Mechanics II	3
PHYS 324	Thermal Physics	3
PHYS 325	Optics	3
PHYS 325L	Optics Laboratory	1
PHYS 327	Electricity and Magnetism I	3
PHYS 328	Electricity and Magnetism II	3
PHYS 415	Undergrad Research Experience	3
PHYS 428	Advanced Physics Laboratory	2
PHYS 431	Quantum Mechanics I	3
PHYS 432	Quantum Mechanics II	3
PHYS 509	Methods of Theoretical Physics	3
PHYS 510	Methods of Theoretical Physics	3
PHYS 539	Quantum Mechanics	3
PHYS 540	Quantum Mechanics	3
PHYS 541	Theory Electricity Magnetism	3
PHYS 542	Theory of Electricity and Magnetism	3
PHYS 545	Analytical Mechanics	3
PHYS 590	Research	1-16
MATH 165	Calculus I	4
MATH 166	Calculus II	4
MATH 207	Introduction to Linear Algebra	2
MATH 265	Calculus III	4
MATH 266	Elementary Differential Equations	3
MATH 352	Introduction to Partial Differential Equations	3
CHEM 121	General Chemistry I	3
CHEM 121L	General Chemistry I Laboratory	1
CHEM 122	General Chemistry II	3
CHEM 122L	General Chemistry II Laboratory	1
Total Credits		92-107

Minor in Astrophysics

A minor in astrophysics is offered for students who are interested in an understanding of the astrophysics of stars, galaxies, and the universe. The astrophysics minor cannot be combined with a major or minor in physics.

Required 25 credits, including:

PHYS 110	Introductory Astronomy	3
PHYS 110L	Introductory Astronomy Lab	1
PHYS 211 & PHYS 211L	College Physics I and	4
PHYS 212 & PHYS 212L	College Physics II and	4
PHYS 213 & PHYS 213L	College Physics III and	4
or PHYS 251 & PHYS 251L	University Physics I and	
PHYS 252 & PHYS 252L	University Physics II and	4
PHYS 253 & PHYS 253L	University Physics III and	4
PHYS 460	Introduction to Astrophysics	3
PHYS 461	Introduction to Astrophysics II	3
Select one of the following:		3
PHYS 415	Undergrad Research Experience	
PHYS 434	Nuclear Physics	
SPST 425	Observational Astronomy	
Total Credits		33

Minor in Physics

Required 20 credits in Physics. The specific courses should be chosen in consultation with the department.

Courses

PHYS 101. Survey of Physics & Astrophysics. 1 Credit.
A survey of a broad range of topics in physics ranging from nanoscience to astrophysics and physics-related educational and career opportunities. Intended to help physics majors and students interested in majoring in physics make informed academic decisions early in their college life. S/U grading. F.

PHYS 110. Introductory Astronomy. 3 Credits.
An introductory study of the universe: The solar system, stars, stellar evolution, galaxies, black holes, big bang cosmology, and the accelerating universe. The astronomy laboratory 110L is optional for 1 credit. F,S.

PHYS 110L. Introductory Astronomy Lab. 1 Credit.
An introductory study of the universe: The solar system, stars, stellar evolution, galaxies, black holes, big bang cosmology, and the accelerating universe. The astronomy laboratory 110L is optional. F,S.

PHYS 130. Natural Science-Physics. 4 Credits.
For non-science majors, this is a hands-on, inquiry-based course on the workings of science. Emphasis is on critical thinking and the use of the scientific method. Topics will include: electricity, force, motion, and energy. The laboratory is a component of this course. S.

PHYS 140. Physics for Poets. 3 Credits.
An introduction to the fundamental concepts of physics, especially those developed in the twentieth century. A knowledge of elementary algebra is recommended, but the course is designed for students with a limited mathematical background. No laboratory. On demand.

PHYS 150. Physics for Aerospace Sciences. 5 Credits.
An introduction to the principles and concepts of physics as they apply to the study of aerospace sciences. Topics: Newtonian mechanics, gravitation, work, energy, fluids, electricity, magnetism. F,S.

PHYS 161. Introductory College Physics I. 4 Credits.
An introduction to the principles and concepts of physics with the application of minimal mathematics, sufficient to show the logical progression from one topic to the next. General physics for those who do not plan to take an advanced course in science. Topics: Newtonian mechanics and gravitation, work and energy, solids and fluids, vibrations and waves, electricity and magnetism, light and optics. The laboratory is a component of this course. No mathematical prerequisite is required, but knowledge of elementary algebra is recommended. F.

PHYS 162. Introductory College Physics II. 4 Credits.
An introduction to the principles and concepts of physics with the application of minimal mathematics, sufficient to show the logical progression from one topic to the next. General physics for those who do not plan to take an advanced course in science. Topics: Newtonian mechanics and gravitation, work and energy, solids and fluids, vibrations and waves, electricity and magnetism, light and optics. The laboratory is a component of this course. Prerequisite: PHYS 161. S.

PHYS 211. College Physics I. 4 Credits.
This non-calculus general physics course is recommended for pre-medical or pre-professional students. Topics: Newtonian mechanics and gravitation, work and energy, solids and fluids, heat and thermodynamics. The laboratory is a component of this course. A student may not receive credit for PHYS 211 and PHYS 212, and also PHYS 161 and PHYS 162. Prerequisite: MATH 103. F.

PHYS 211C. College Physics I. 3 Credits.
This non-calculus general physics course is recommended for pre-medical or pre-professional students. Topics: Newtonian mechanics and gravitation, work and energy, solids and fluids, heat and thermodynamics. Students requiring a laboratory must take PHYS 211CL. Prerequisite: MATH 103. F.

PHYS 211CL. College Physics I Laboratory. 1 Credit.
The laboratory part of Physics 211C. Prerequisite: PHYS 211C or consent of instructor. S/U grading. SS.

PHYS 212. College Physics II. 4 Credits.
The non-calculus general physics course sequence recommended for pre-medical or preprofessional students. Topics: vibrations and waves, electricity and magnetism, light and optics, and an introduction to modern physics. The laboratory is a corequisite for this course. The laboratory is a component of this course. A student may not receive credit for PHYS 211 and PHYS 212, and also PHYS 161 and PHYS 162. Prerequisite: PHYS 211. S.

PHYS 212C. College Physics II. 3 Credits.
The non-calculus general physics course sequence recommended for pre-medical or preprofessional students. Topics: vibrations and waves, electricity and magnetism, light and optics, and an introduction to modern physics. Students requiring a laboratory with this course must take PHYS 212CL. Prerequisite: PHYS 211C or PHYS 211. S.

PHYS 212CL. College Physics II Laboratory. 1 Credit.
The laboratory part of Physics 212C. Prerequisite: PHYS 212C or consent of instructor. S/U grading. SS.

PHYS 213. College Physics III. 4 Credits.
A survey of modern physics covering physical optics, special theory of relativity, quantum theory, atomic physics, molecular and solid state physics, nuclear physics and radioactivity, particle physics, and astrophysics. The laboratory is a component of this course. Prerequisite: PHYS 212. F.

PHYS 251. University Physics I. 4 Credits.
The university physics sequence is for students majoring in science and engineering. Topics normally covered in PHYS 251 include Newtonian mechanics and gravitation, work and energy, rotational dynamics, vibrations and waves, mechanics of solids and fluids, basic kinetic theory, equations of state and the first and second laws of thermodynamics. The laboratory is a component of this course. Prerequisite: MATH 165. F,S.

PHYS 252. University Physics II. 4 Credits.
Topics normally covered include electricity, magnetism, electromagnetic waves, light and geometrical optics. The laboratory is a component of this course. Prerequisites: MATH 166 and PHYS 251. F,S.

PHYS 253. University Physics III. 4 Credits.
Modern physics, a survey covering physics of the 20th and 21st centuries. Topics normally covered include theory of relativity, discovery of quantum phenomena, basic quantum mechanics, overview of atomic, nuclear and solid state physics, statistical physics, quantum fluids and superconductivity, fundamental forces and the physics of elementary particles. This course is a prerequisite for most courses in advanced physics. The laboratory is a component of this course. Prerequisites: MATH 265 and PHYS 252. S.

PHYS 294. Selected Topics. 1-4 Credits.
Prerequisite: 8 hours of college physics or consent of instructor. Repeatable to 4 credits. On demand.

PHYS 317. Mechanics I. 3 Credits.
Motion of a single particle, central forces and simple oscillatory systems. Prerequisites: PHYS 251 and MATH 266, or approval of department. F.

PHYS 318. Mechanics II. 3 Credits.
Rigid body motion, Lagrangian and Hamiltonian dynamics, relativity, continuum mechanics. Prerequisite: PHYS 317 or approval of instructor. S.

PHYS 320. Introduction to Materials Science. 3 Credits.
An introduction to solid state physics with emphasis on applications. Prerequisite: PHYS 253 or approval of department. F, even years.

PHYS 324. Thermal Physics. 3 Credits.
Thermodynamics with an introduction to statistical physics. Prerequisite: PHYS 253 or approval of instructor. S, even years.

PHYS 325. Optics. 3 Credits.
Geometrical and physical optics with an emphasis on physical optics. Prerequisite: PHYS 253 or approval of department. S, odd years.

PHYS 325L. Optics Laboratory. 1 Credit.
Laboratory to accompany Physics 325. Corequisite: PHYS 325. S, odd years.

PHYS 327. Electricity and Magnetism I. 3 Credits.
A quantitative treatment of electromagnetic theory with an introduction to Maxwell's equations. Prerequisite: PHYS 253 or approval of instructor. F, odd years.

PHYS 328. Electricity and Magnetism II. 3 Credits.
Maxwell's equations. The scalar potential as a solution of a boundary value problem. The vector potential and its application. A quantitative treatment of dielectrics, magnetic materials and electromagnetic radiation. Prerequisite: PHYS 327. Corequisite: MATH 352 or approval of instructor. S, even years.

PHYS 402. Computers in Physics. 3 Credits.
Computer applications in physics, that may include data analysis, numerical simulation, symbolic and algebraic programming, parallel computing, computer interfacing and/or experimental physics applications. Prerequisites: PHYS 252 and knowledge of a higher-level computer programming language, or consent of instructor. On demand.

PHYS 415. Undergrad Research Experience. 3 Credits.
The students will engage in research activities of a UND physics faculty member or may take part in a physics department approved external research program such as an NSF-funded REU program. Prerequisite: PHYS 253 or advisor's consent.

PHYS 420. Advanced Topics in Materials Science. 3 Credits.
The application of physics to design, synthesis and characterization of materials of current interest. Prerequisite: PHYS 320. S, odd years.

PHYS 428. Advanced Physics Laboratory. 2 Credits.
Advanced undergraduate experiments in physics, using modern techniques and instrumentation. Classic experiments leading to the current understanding of physical theory. Prerequisite: PHYS 253 or approval of instructor. F, odd years.

PHYS 431. Quantum Mechanics I. 3 Credits.
An introduction to quantum mechanics with applications to atomic structure. Prerequisite: PHYS 253. Prerequisite or Corequisite: PHYS 317 or approval of department. F, even years.

PHYS 432. Quantum Mechanics II. 3 Credits.
Further development of basic quantum theory with application to atomic, molecular, solid state and nuclear physics. Prerequisite or Corequisite: PHYS 431 or consent of instructor. S, odd years.

PHYS 434. Nuclear Physics. 3 Credits.
Introduction to the theory of atomic nuclei, fundamental forces and sub-atomic particles. Prerequisite: PHYS 253 or approval of instructor. F, odd years.

PHYS 437. Introductory Solid State Physics. 3 Credits.
A general introduction to solid state phenomena. Prerequisite: PHYS 253 or approval of instructor. F, even years.

PHYS 460. Introduction to Astrophysics. 3 Credits.
Nature of stars. Topics include celestial mechanics, relativity, optics, stellar birth, stellar interiors and evolution, nucleosynthesis, stellar death, compact objects, black holes, neutron stars, white dwarfs, binaries and variable stars. Some topics include the use of computer tools to solve problems. Prerequisite: PHYS 253 or approval of instructor. F, even years.

PHYS 461. Introduction to Astrophysics II. 3 Credits.
Galaxies and the universe. Topics include structure and evolution of galaxies, the Milky Way, stellar populations, globular clusters, interstellar medium, big bang, Hubble and the distance scale, radio galaxies, quasars, jets, blazars, clusters and superclusters of galaxies and cosmology. Some topics include the use of computer tools to solve problems. Prerequisite: PHYS 460 or approval of instructor. S, odd years.

PHYS 489. Senior Honors Thesis. 1-15 Credits.

PHYS 492. Special Problems. 1-3 Credits.
Selected problems in physics or astrophysics. Prerequisite: Approval of the department. Repeatable to 9 credits. On demand.