Physics

College of Science, Engineering & Technology
Department of Physics & Astronomy
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Physics is a science concerned with understanding the fundamental laws of nature. It explains physical phenomena in everyday life, such as motion, heat, electricity, magnetism and light. It studies the origin of the universe, the behavior of atoms and subatomic particles, and everything in between. Physics is the foundation of all fields of science and engineering.

The physics curriculum consists of sequences of interrelated courses that must be taken in the appropriate order. Mathematics is an important tool for physics. The courses taken by physics majors cover a variety of topics in classical and modern physics, and require significant preparations in mathematics. Well prepared students should complete the physics major in four years. The physics B.S. program prepares students for:

1. Further study in physics, engineering, or other fields for advanced degrees,
2. Entry into work in the public or private sectors,
3. Teaching physics in high schools if the B.S. in physics teaching degrees is earned.

Training in physics gives students strong abilities in critical thinking and problem solving, the two skills that are essential in any occupation.

Academic Map/Degree Plan at www.mnsu.edu/programs/#All

POLICIES/INFORMATION
Admission to the major is granted by the department. To be admitted to the major, a student must have a minimum of 32 earned credit hours and a minimum cumulative GPA of 2.00 (C).

Contact the College of Science, Engineering and Technology Advising Center for application procedures.

GPA policy. A minimum GPA of 2.0 in physics courses is required for graduation. P/N grading policy. All physics courses except PHYS 105 and PHYS 480 are open to P/N grading. However, a student majoring or minoring in physics must elect the grade option for all of the required courses except where P/N grading is mandatory.

A minimum of 25 percent of the required credits in physics must be taken at Minnesota State University, Mankato for both the major and the minor. Testing for advanced standing is available on a case-by-case basis as determined by the chairperson of the Physics and Astronomy department.

BS degree, Double major. Students majoring in physics often find a second major in mathematics to be an attractive option. If the BS degree in mathematics is combined with a BS degree in physics, then the following math courses are recommended: MATH 345, MATH 422, MATH 425, and MATH 447.

PHYSICS BS
Degree completion = 120 credits

Students interested in physics preparation leading to professional opportunities or graduate study are encouraged to select this major.

Required General Education
MATH 121 Calculus I (4)
PHYS 221 General Physics I (4)

Major Common Core
CS 110 Computer Science I (4)
EE 230 Circuit Analysis I (3)
EE 240 Evaluation of Circuits (1)
MATH 122 Calculus II (4)
MATH 223 Calculus III (4)
MATH 247 Linear Algebra I (4)

Required General Education
MATH 321 Ordinary Differential Equations (4)
PHYS 150 Explorations in Physics (1)
PHYS 222 General Physics II (3)
PHYS 223 General Physics III (3)
PHYS 232 General Physics Laboratory I (1)
PHYS 233 General Physics Laboratory II (1)
PHYS 335 Modern Physics I (3)
PHYS 336 Modern Physics II (3)
PHYS 441 Mechanics (4)
PHYS 447 Electricity & Magnetism I (3)
PHYS 448 Electricity & Magnetism II (3)
PHYS 457 Optics (3)
PHYS 461 Quantum Mechanics (4)
PHYS 465 Computer Applications in Physics (3)
PHYS 473 Statistical Physics (3)
PHYS 475W Advanced Laboratory (3)
PHYS 492 Seminar (1)

Major Unrestricted Electives
Required Electives (choose 4 credits)
AST 351 Telescope Operations (2)
AST 353 Photometry I (2)
AST 355 Astrometry (2)
AST 357 Spectroscopy (2)
AST 420 Stellar Astrophysics (3)
AST 430 Galactic Structure (3)
EE 303 Introduction to Solid State Devices (3)
EE 304 Lab: Introduction to Solid State Devices (1)
MATH 354 Concepts of Probability & Statistics (4)
MATH 411 Introduction to Complex Variables (4)
MATH 422 Partial Differential Equations (4)
MATH 470 Numerical Analysis I (4)
PHYS 417 Biophysics (2)
PHYS 453 Solid State Physics (3)
PHYS 493 Graduate Research (1-6)
PHYS 499 Individual Study (1-8)
STAT 354 Concepts of Probability & Statistics (4)

Required Minor: None.

PHYSICS MINOR

Required General Education
MATH 121 Calculus I (4)
PHYS 221 General Physics I (4)

Required Support Course
MATH 122 Calculus II (4)

Required for Minor
PHYS 222 General Physics II (3)
PHYS 223 General Physics III (3)
PHYS 335 Modern Physics I (3)
PHYS 336 Modern Physics II (3)

Required Elective (2-4 credits)
Choose a minimum of one course from the following courses:
PHYS 441 Mechanics (4)
PHYS 447 Electricity & Magnetism I (3)
PHYS 457 Optics (3)
PHYS 465 Computer Applications in Physics (3)
PHYS 473 Statistical Physics (3)
PHYS 475 Advanced Laboratory (3)

PHYSICS SCIENCE TEACHING BS
Degree completion = 120 credits

Other Graduation Requirements
See the SECONDARY EDUCATION section for admission requirements to Professional Education and a list of required professional education courses.

Required General Education (3 credits)
Recommended General Education (22-23 credits) including MATH 121
Required General Science Core (31-33 credits)
Required for Major

MATH 122 Calculus II (4)
PHYS 335 Modern Physics I (3)
PHYS 336 Modern Physics II (3)
PHYS 381 Tutoring Physics (2)
PHYS 465 Computer Applications in Physics (3)
PHYS 482 Teaching Methods & Materials in Physical Science (4)
PHYS 493 Undergraduate Research (1-6) (2 credits required)

Electives (Minimum of 8 Credits)*

Students may use PHYS 221, PHYS 222, PHYS 223, PHYS 232, and PHYS 233 to fulfill their Physics Electives requirement only if PHYS 211 and PHYS 212 are completed successfully.

Alternatively, students with a strong interest in applying advanced mathematical skills to problems in physics are encouraged to choose a minimum of 8 credits* of higher level Physics or Mathematics as approved by the student’s advisor to fulfill the Physics Elective requirement.

*This is reduced to 4 credits if PHYS 221, PHYS 222, PHYS 223, PHYS 232, and PHYS 233 have been taken in place of PHYS 211 and PHYS 212 in partial fulfillment of the General Science Core requirements.

Students intending to teach physics in states other than Minnesota are advised to select the BS Physics major and use elective credits to satisfy the professional education course requirements. For additional information confer with the science teaching advisor.

COURSE DESCRIPTIONS

PHYS 100 (3) Cultural Physics
Self-paced format, open laboratory component. Includes the history, philosophy, and growth of science from myth to the present. Included are readings on Galileo, Self-paced format, open laboratory component. Includes the history, philosophy, and growth of science from myth to the present. Included are readings on Galileo, Albert Einstein (a biography of the primary developer of the Theory of Relativity); and the Theory of Relativity. All the readings are written to be understood by non-scientists.

PHYS 101 (3) Introductory Physics
A one semester course which covers the basic principles of physics on a conceptual level and with a minimal amount of math. The course provides an understanding of natural processes and their applications. Topics generally include mechanics, simple machines, atomic structure, heat, light, and sound. Lecture and laboratory components.

PHYS 102 (3) Physics in the World Around Us
A one semester course which covers the basic principles of physics on a conceptual level. The course provides an understanding of natural processes and their applications to technology (or how things work!), including the greenhouse effect and nuclear power. Lecture only.

PHYS 105 (3) Time, Atomic Clocks, and Relativity
Self-paced format. Includes readings on time, telling time from sundials to atomic clocks; Albert Einstein (a biography of the primary developer of the Theory of Relativity); and the Theory of Relativity. All the readings are written to be understood by non-scientists.

PHYS 150 (1) Explorations in Physics
This course offers an introduction to the field of physics, and prepares students for academic success in the program. Students will become familiar with current topics of physics research within the department, and better understand the career paths available with a physics major.

PHYS 211 (4) Principles of Physics I
General background in physical concepts for those who do not plan advanced study in physics or engineering. Topics include mechanics, fluids, heat and thermodynamics. Lecture and laboratory.
Prerequisite: Either MATH 112 and MATH 113, or MATH 115; and high school physics or PHYS 101.
Fall, Spring
GE-2, GE-3

PHYS 212 (4) Principles of Physics II
Includes waves and sound, electricity and magnetism, light and optics, and topics in modern physics. Lecture and laboratory.
Prerequisite: PHYS 211
Fall, Spring

PHYS 221 (4) General Physics I
Designed for science and engineering students. Calculus-based physics. Covers elementary mechanics including kinematics, statics, equilibrium and dynamics of particles, work and energy, rotational motion, gravitation, and oscillation. Lecture and laboratory.
Prerequisite: MATH 121 with a "C" or better, and high school physics or PHYS 101
Fall, Spring
GE-2, GE-3

PHYS 222 (3) General Physics II
Designed for science and engineering students. Calculus-based physics. Covers electricity and magnetism, fields and their sources, current and resistance, simple DC and AC circuits; and electromagnetic induction. Lecture only. (Associated laboratory course is PHYS 231.)
Prerequisite: MATH 122 with a "C" or better, and PHYS 221 with a "C" or better.
Fall, Spring

PHYS 223 (3) General Physics III
Designed for science and engineering students. Calculus-based physics. Covers fluids, thermodynamics, mechanical and sound waves, geometrical optics, physical optics, and modern physics. Lecture only. (Associated laboratory course is PHYS 233.)
Prerequisite: MATH 122 with a "C" or better, and PHYS 221 with a “C” or better.
Spring

PHYS 232 (1) General Physics II Laboratory
Designed for science and engineering students. Laboratory course accompanying PHYS 222. Experiments involving electric and magnetic fields, electric potential, electric and magnetic forces, and simple circuits. Laboratory only.
Prerequisite: PHYS 221 with a “C” or better, and PHYS 222 or concurrent.
Fall, Spring

PHYS 233 (1) General Physics III Laboratory
Designed for science and engineering students. Laboratory course accompanying PHYS 223. Experiments involving fluids, thermodynamics, mechanical waves, geometrical optics, and optical physics. Laboratory only.
Prerequisite: PHYS 221 with a “C” or better, and PHYS 223 or concurrent.
Spring

PHYS 335 (3) Modern Physics I
Prerequisite: MATH 122, PHYS 222 and concurrently with PHYS 233 or PHYS 212.
Spring

PHYS 336 (3) Modern Physics II
Topics include the basics of molecular structure and spectra, classical and quantum statistical physics, solid state physics, nuclear physics, and particle physics. The lab component will teach the operation of various radiation detectors, and use them to study the interaction of radiation with matter.
Prerequisite: PHYS 335
Fall

PHYS 381 (1-3) Tutoring Physics
Supervised experience as an instructional assistant. Must demonstrate ability in basic physics.
Prerequisite: Consent
Variable
PHYS 417 (2) Biophysics
This course bridges the gap between introductory physics and its application to the life and biomedical sciences. Topics include fluid flow, membrane transport, nerve conduction, imaging methods including MRI, CT, and nuclear imaging, radiotherapy, and health physics.
Prerequisite: MATH 121, PHYS 212 or PHYS 222
Variable

PHYS 441 (4) Mechanics
Rectilinear motion of a particle, general motion of a particle in three dimensions, Newtonian mechanics including harmonic oscillations, forced oscillations, central forces and orbital motion, collisions, noninertial reference systems, dynamics of a system of particles, rigid body motion, Lagrangian and Hamiltonian mechanics, normal coordinates.
Prerequisite: Phys 222 or Phys 223, and MATH 321 or consent.
Fall

PHYS 447 (3) Electricity & Magnetism I
Electrostatic fields, magnetostatic fields, steady currents, electromagnetic induction. Review of vector algebra.
Prerequisite: MATH 223 and MATH 321 and PHYS 222
Fall

PHYS 448 (3) Electricity & Magnetism II
Electromagnetic waves, propagation and radiation of waves, electrodynamics and relativity.
Prerequisite: PHYS 223 and PHYS 447
Spring

PHYS 453 (3) Solid State Physics
Atoms in crystals, wave in crystals, thermal vibrations of the crystal lattice, free electron model, band theory of solids, semiconductors and PN junctions, magnetism, and superconductivity.
Prerequisite: PHYS 335
Variable

PHYS 457 (3) Optics
Geometric optics, wave optics, properties of light and matter, optics of transformations, and quantum optics. Lecture and laboratory.
Prerequisite: MATH 122 and PHYS 223
ODD-Spring

PHYS 461 (4) Quantum Mechanics
A systematic development of foundations of quantum mechanics. Observables, operators, state functions, expectation values. Matrix formulation of eigenvalue problems. The hydrogen atom, electron spin, angular momentum, and perturbation theory.
Prerequisite: Phys 335, PHYS 441, MATH 247, MATH 321
Fall

PHYS 465 (3) Computer Applications in Physics
Numerical solutions of physics problems and computer simulations of physical systems. Lecture and laboratory.
Prerequisite: MATH 122, CS 110 and PHYS 222 or PHYS 223.
Fall

PHYS 473 (3) Statistical Physics
Fundamental principles of statistical physics, including theory of probability, kinetic theory of transport process, entropy, classical and quantum statistical ensembles, Bose and Fermi systems. Applications to thermodynamics and magnetic properties of solids.
Prerequisite: MATH 321 and PHYS 223
Alt-Spring

PHYS 475 (3) Advanced Laboratory
Experiments in modern physics, including solid-state physics and optics. Requires more independent work than introductory laboratories.
Prerequisite: PHYS 336 or consent
Spring

PHYS 475W (3) Advanced Laboratory
Experiments in modern physics, including solid-state physics and optics. Requires more independent work than introductory laboratories.
Prerequisite: PHYS 336 or consent
Spring