Physics
College of Science, Engineering & Technology
Department of Physics & Astronomy
141 Trafton Science Center N • 507-389-5743
Web site: www.mnsu.edu/physast
Chair: Mark A. Pickar
Thomas R. Brown, Robert J. Herickhoff, Igor Kogoutiouk, Louis A. Schwartzkopf, Hai-Sheng Wu, Youwen Xu

The physics programs available to the student are designed to prepare the student for graduate work, for a career in industry or government, or for high school teaching. Degree requirements provide graduates with laboratory skills useful both in graduate work and in industry and business.

Admission to Major is granted by the department. Minimum University admission requirements are:
- a minimum of 32 earned semester credit hours.
- a minimum cumulative GPA of 2.00 (C).
Contact the department for application procedures.

PHYSICS BA
This major is intended to prepare the student for work in industry or business after the bachelor's degree rather than for graduate work.

Required General Education (9 credits):
MATH 121 Calculus I (4)
PHYS 221 General Physics I (5)

Recommended Support Courses (18 credits):
CHEM 201 General Chemistry I (5)
CHEM 202 General Chemistry II (5)
COMS 272 FORTRAN Programming (4)
ENG 271 Technical Communication (4)

Required for Major (46 credits):
EE 230 Circuit Analysis I (3)
EE 240 Evaluation of Circuits (1)
MATH 122 Calculus II (4)
MATH 223 Calculus III (4)
MATH 321 Ordinary Differential Equations (4)
PHYS 222 General Physics II (5)
PHYS 435 Modern Physics I (3)
PHYS 436 Modern Physics II (3)
PHYS 441 Mechanics (4)
PHYS 447 Electricity and Magnetism I (3)
PHYS 457 Optics (3)
PHYS 461 Quantum Mechanics (4)
PHYS 465 Computer Applications in Physics (3)
PHYS 473 Statistical Physics (3)
PHYS 475 Advanced Laboratory (2)

Required Electives (3 credits):
Choose one of the following:
PHYS 435 Modern Physics I (3)
PHYS 436 Modern Physics II (3)

Required Minor: None.

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

Required General Education (9 credits):
MATH 121 Calculus I (4)
PHYS 221 General Physics I (5)

Recommended Support Courses (22 credits):
CHEM 201 General Chemistry I (5)
CHEM 202 General Chemistry II (5)
COMS 272 FORTRAN Programming (4)
ENG 271 Technical Communication (4)
MATH 422 Partial Differential Equations (4)

Required for Major (55 credits):
EE 230 Circuit Analysis I (3)
EE 240 Evaluation of Circuits (1)
MATH 122 Calculus II (4)
MATH 223 Calculus III (4)
MATH 321 Ordinary Differential Equations (4)
PHYS 222 General Physics II (5)
PHYS 435 Modern Physics I (3)
PHYS 436 Modern Physics II (3)
PHYS 441 Mechanics (4)
PHYS 447 Electricity and Magnetism I (3)
PHYS 448 Electricity and Magnetism II (3)
PHYS 453 Solid State Physics (3)
PHYS 457 Optics (3)
PHYS 461 Quantum Mechanics (4)
PHYS 465 Computer Applications in Physics (3)
PHYS 473 Statistical Physics (3)
PHYS 475 Advanced Laboratory (2)

Required Minor: None.

PHYSICAL SCIENCE TEACHING BS
Requirements for programs in teaching the physical sciences can be found in the SCIENCE TEACHING section of this bulletin. There is a new physics teaching program which will take effect for students applicant for licensure after September 2001.

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

POLICIES/INFORMATION
GPA Policy. A minimum GPA of 2.0 in physics courses is required for graduation.

Refer to the College regarding required advising for students on academic probation.

P/N Grading Policy. All physics courses except PHYS 105 and 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.

A minimum of 25 percent of the required credits in physics must be taken at MSU for both the major and the minor. Testing for credit by examination is available on a case-by-case basis as determined by the Physics and Astronomy Department chairperson.
Electives in physics may include AST 420 and/or 421. Students may receive credit for only one course in each of the following pairs of courses: PHYS 211 and 221, 212 and 222. Four credits of 100-level courses may be allowed toward the BS (teaching) major, provided they are completed before PHYS 211 (221). PHYS 482 counts only toward the BS teaching degree.

BS Degree, Double Major. Students majoring in physics often find a second major in mathematics or astronomy to be an attractive option. If the BS degree in physics is combined with a BS degree in mathematics, then the following math courses are recommended: MATH 345, 321, 422, 425, and 447.

**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, Newton, the Industrial Revolution, and the modern scientific revolution. The relationship of science to art, archaeology, politics, weapons, medicine, technology, research and development, and the universe are discussed.

F, S

**GE-3**

**Variable**

**PHYS 105 (3) Time, Atomic Clocks, and Relativity**
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.

F, S

**GE-3**

**Variable**

**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 to technology (or how things work!), including the greenhouse effect and nuclear power. Lecture only.

**Variable**

**GE-3**

**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.

**Variable**

**GE-3**

**PHYS 107 (3) Physics of Flight**
A one semester course which covers the basic principles of physics and flying on a conceptual level. Minimal math will be required. The course provides an understanding of physics and how it applies to the technology of flight. Topics include lift and drag; power plants and propulsion; stability; control; aircraft performance and history; subsonic and supersonic aerodynamics. Intended for students interested in aviation. Lecture, discussion, guided experiences at the University and at the Mankato airport.

**Variable**

**GE-3**

**PHYS 110 (3) Physics and Our Audio Environment**
A one semester course which covers the basic principles of physics as they apply to audio systems, their specifications, and our audio environment. Presented at a conceptual level. Lecture and laboratory.

**Variable**

**GE-3**

**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.

Pre: Either MATH 112 and 113, or MATH 115; and high school physics or PHYS 101; or consent F, S

**GE-2, 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.

Pre: PHYS 211 F, S

**PHYS 221 (5) General Physics I**
Designed for science and engineering students. Covers elementary mechanics including dynamics of particles, work and energy, rotational motion, and gravitation. Also discusses oscillations and thermodynamics. Lecture and laboratory.

Pre: MATH 121; and high school physics or PHYS 101 F, S

**GE-2, 3**

**PHYS 222 (5) General Physics II**
Designed for science and engineering students. Covers waves and sound, electricity and magnetism, DC and AC circuits, electromagnetic waves, geometrical and wave optics, and modern physics. Lecture and laboratory.

Pre: PHYS 221 F, S

**PHYS 381 (1-3) Tutoring Physics**
Supervised experience as an instructional assistant. Must demonstrate ability in basic physics.

Pre: Consent Variable

**PHYS 404 (2) Physics and Society**
Relations between physics and other intellectual communities: e.g., philosophy, humanities, social sciences, the arts.

Pre: Consent Variable

**PHYS 417 (2) Biophysics**
Thermodynamic relationships; energy flow in living systems; metabolic heat generation and loss; homeostasis; atomic and molecular bonds in nucleic acids, proteins, and carbohydrates; hormonal regulation; cell metabolism; negative feedback control in living systems; cancer therapy; imaging; disease states; new theories and paradigms.

Pre: PHYS 212 or 222 and MATH 122 Variable

**PHYS 435 (3) Modern Physics I**

Pre: PHYS 212 or 222 and MATH 122 S

**PHYS 436 (3) Modern Physics II**
Topics include nuclear force, interactions of nuclear particles with matter, radioactive decay, nuclear structure, nuclear reactions, fission, fusion, elementary particles, and the quark model. Lecture and laboratory.

Pre: PHYS 435 F

**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 particles, rigid body motion, Lagrangian and Hamiltonian mechanics, normal coordinates.

Pre: PHYS 212 or 222 and MATH 223 F

**PHYS 447 (3) Electricity & Magnetism I**
Electrostatic fields, magnetostatic fields, steady currents, electromagnetic induction. Review of vector algebra.

Pre: PHYS 212 or 222 and MATH 223, 321, or 422 F
PHYS 448 (3) Electricity & Magnetism II
Electromagnetic waves, propagation and radiation of waves, electrodynamics and relativity.
Pre: PHYS 447 S

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.
Pre: PHYS 435 ODD-S

PHYS 457 (3) Optics
Geometric optics, wave optics, properties of light and matter, optics of transformations, and quantum optics. Lecture and laboratory.
Pre: PHYS 212 or 222 and MATH 122 ODD-S

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.
Pre: PHYS 435, 441, and MATH 321 F

PHYS 465 (3) Computer Applications in Physics
Numerical solutions of physics problems and computer simulations of physical systems. Lecture and laboratory.
Pre: Familiarity with some programming language, and PHYS 212 or 222, and MATH 122; or consent F

PHYS 467 (3) Semiconductor Device Physics
Introduction to theory and techniques of integrated circuit fabrication processes. Oxidation, photolithography, etching, diffusion of impurities, ion implantation, epitaxy, metallization, material characterization techniques, and VLSI process integration, their design and simulation by SUPREM. Same as EE 475.
Pre: PHYS 435 and 453 F

PHYS 468 (1) Semiconductor Device Physics Laboratory
Introduction to integrated circuit fabrication processes, device layout, mask design, and experiments related to wafer cleaning, etching, thermal oxidation, thermal diffusion, photolithography, and metallization. Fabrication of basic integrated circuit elements: pn junctions, resistors, MOS capacitors, simulation or the fabrication process by SUPREM. Same as EE 480.
Pre: PHYS 212 or 222, and MATH 122; or consent F

PHYS 473 (3) Statistical Physics
Statistical mechanics, kinetic theory, thermodynamics.
Pre: PHYS 212 or 222 and MATH 223 and 321 EVEN-S

PHYS 475 (2) Advanced Laboratory
Experiments in modern physics, including solid-state physics and optics. Requires more independent work than introductory laboratories.
Pre: PHYS 436 or consent S

PHYS 480 (2) Lab Experiences in Physical Science
For prospective teachers in elementary schools. Topics include weather, weather forecasting and record keeping, simple machines, electricity, chemistry, sound, light, and others. May not count as a physics elective. Not available for P/N grading.
Pre: PHYS 101 F, S

PHYS 482 (4) Teaching Methods and Materials in Physical Science
Current methods of teaching all physical sciences with emphasis on physics and chemistry. For students planning to teach at a middle school, secondary school, college, or a university.