

## PHYSICS

### Physics

College of Science, Engineering & Technology  
Department of Physics & Astronomy  
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Chair: Youwen Xu

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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 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.

#### 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 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.

A minimum of 25 percent of the required credits in physics must be taken at Minnesota State Mankato 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 AST 421. Four credits of 100-level courses may be allowed toward the BS (teaching) major, provided they are completed before PHYS 211 (PHYS 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, MATH 321, MATH 422, MATH 425, and MATH 447.

#### PHYSICS BS

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

##### **Required General Education (8 credits)**

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

##### **Required Support Courses (16 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)

##### **Required for Major (Core, 40 credits)**

PHYS 222 General Physics II (3)  
PHYS 223 General Physics III (3)  
PHYS 232 General Physics II Laboratory (1)  
PHYS 233 General Physics III Laboratory (1)  
PHYS 335 Modern Physics I (3)  
PHYS 336 Modern Physics II (3)  
PHYS 441 Mechanics (4)  
PHYS 447 Electricity and Magnetism I (3)  
PHYS 448 Electricity and 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 475 Advanced Laboratory (2)  
PHYS 492 Seminar (1)

##### **Required Electives (4 credits)**

(Choose a minimum of 4 credits from the following courses)

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 (3) **OR**  
STAT 354 Concepts of Probability & Statistics (3)  
MATH 411 Introduction to Complex Variables (4)  
MATH 422 Partial Differential Equations (4)  
MATH 470 Numerical Analysis I (4)  
PHYS 493 Undergraduate Research (1-6)  
PHYS 499 Individual Study (1-8)

##### **Recommended Support Courses**

CHEM 201 General Chemistry I (5)  
CHEM 202 General Chemistry II (5)  
CS 110 Computer Science I (4)  
ENG 271 Technical Communication (4)  
MATH 247 Linear Algebra I (4)  
MATH 422 Partial Differential Equations (4)

**Required Minor: None.**

#### PHYSICS MINOR

##### **Required General Education (8 credits)**

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

##### **Required Support Course (4 credits)**

MATH 122 Calculus II (4)

##### **Required for Minor (Core, 12 credits)**

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 (2)

## PHYSICS

### PHYSICS SCIENCE TEACHING BS

General requirements for programs in teaching the sciences can be found in the SCIENCE TEACHING section of this bulletin.

#### **Required General Education (3 credits)**

#### **Recommended General Education (22-23 credits)**

Including MATH 121

#### **Required General Science Core (31-33 credits)**

#### **Required Professional Education (30 credits)**

#### **Required for Major (Core, 21 credits)**

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, 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. Lab included.

Fall, Spring  
GE-3

#### **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.

Fall, Spring  
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 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.

Fall, Spring  
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 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.

Pre: 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.

Pre: 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 electrical charge and field; magnetic field and its sources; current and resistance; simple DC and AC circuits; and electromagnetic induction. Lecture only. (Associated laboratory course is PHYS 232.)

Pre: 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.)

Pre: MATH 122 with a "C" or better; and PHYS 221 with a "C" or better.  
Spring

## PHYSICS

### **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.

Pre: 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 physical optics. Laboratory only.

Pre: PHYS 221 with a "C" or better; and PHYS 223 or concurrent.

Spring

### **PHYS 335 (3) Modern Physics I**

Special Theory of Relativity. Quantum nature of waves and particles: photons, de Broglie wavelength of matter and wave packet description of particles, Bohr model of hydrogen. Schrodinger wave equation in one-dimension: energy quantization, potential barriers, simple harmonic oscillator. One-electron atoms. X-ray and optical excitation of multielectron atoms. Lecture and laboratory.

Pre: MATH 122; (PHYS 222 and concurrently with PHYS 223) or PHYS 212.

Spring

### **PHYS 336 (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 335

Fall

### **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 PHYS 222 and MATH 122

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.

Pre: 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.

Pre: 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.

Pre: 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.

Pre: 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.

Pre: 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.

Pre: PHYS 335, PHYS 441, and MATH 321

Fall

### **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 MATH 122; and PHYS 222 or PHYS 223; or consent.

Fall

### **PHYS 473 (3) Statistical Physics**

Statistical mechanics, kinetic theory, thermodynamics.

Pre: MATH 321 and PHYS 223

EVEN-Spring

### **PHYS 475 (2) Advanced Laboratory**

Experiments in modern physics, including solid-state physics and optics. Requires more independent work than introductory laboratories.

Pre: PHYS 336 or consent

Spring

### **PHYS 480 (3) 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.

Fall, Spring

### **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.

Pre: CI 447, one year of chemistry and one year of physics, or consent

Spring

### **PHYS 484 (2) Middle/Junior High Science Teaching**

Current methods of teaching all sciences with emphasis on physical science, physics, chemistry, and earth science.

Pre: Majority of required courses completed, or consent

Variable

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## PHYSICS

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### **PHYS 490 (2-4) Workshop**

A short course devoted to a specific topic in physics. May be repeated for credit on each new topic.

Variable

### **PHYS 491 (1-8) In-Service**

A course designed to upgrade the qualifications of persons on-the-job.

Variable

### **PHYS 492 (1) Seminar**

Students will attend research seminars presented by faculty in the department, or speakers from other institutions. Students also make and critique presentations made by themselves and other students. May be repeated for credit.

Pre: Completed at least two upper division physics courses.

Spring

### **PHYS 493 (1-6) Undergraduate Research**

Pre: Consent

Variable

### **PHYS 495 (1-2) Selected Topics**

A course in an area of physics not regularly offered. Topic and credit assigned by department each time offered.

Pre: PHYS 335 and PHYS 336

Variable

### **PHYS 497 (1-16) Internship**

Provides a student with the opportunity to gain expertise and experience in a special field under the supervision of a qualified person.

Pre: Usually Sr. standing

Variable

### **PHYS 499 (1-8) Individual Study**

Special arrangements must be made with an appropriate faculty member of the department office. May be repeated for credit on each new topic.

Pre: Consent

Variable