

## PHYSICS

### Physics

College of Science, Engineering & Technology  
Department of Physics & Astronomy  
141 Trafton Science Center N • 507-389-5743  
Web site: [www.mnsu.edu/physast](http://www.mnsu.edu/physast)

Chair: Mark A. Pickar

Thomas R. Brown, Robert J. Herickhoff, Igor Kogoutiuk, Russell L. Palma, 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 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	FORTAN Programming (4)
ENG	271	Technical Communication (4)
MATH	422	Partial Differential Equations (4)

Required for Major (53 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	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 Minor: None.

#### PHYSICS MINOR

Required Support Courses (8 credits):

MATH	121	Calculus I (4)	MATH	122	Calculus II (4)
------	-----	----------------	------	-----	-----------------

Required for Minor (14-16 credits):

Choose one of the following sequences of introductory physics courses:

PHYS	221	General Physics I (5) AND
PHYS	222	General Physics II (5) OR
PHYS	211	Principles of Physics I (4) AND
PHYS	212	Principles of Physics II (4)

Also Required:

PHYS	435	Modern Physics I (3)
PHYS	436	Modern Physics II (3)

Required Elective

Choose a minimum of one course from the following courses:

PHYS	441	PHYS	447	PHYS	461	PHYS	465	PHYS	453
PHYS	457	PHYS	467	PHYS	473	PHYS	475		

#### 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	381	Tutoring Physics (2)
PHYS	435	Modern Physics I (3)
PHYS	436	Modern Physics II (3)
PHYS	465	Computer Applications in Physics (3)
PHYS	482	Teaching Methods & Materials in Physical Science (4)
PHYS	493	Undergraduate Research (2)

Electives (Minimum of 8 Credits)\*

Students may use Physics 221 and 222 to fulfill their Physics Electives requirement only if Physics 211 and 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 6 credits if Physics 221 and 222 have been taken in place of 211 and 212 in partial fulfillment of the General Science Core requirements.

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 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 421. 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 CD-Related

#### 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.

F, S

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.

F, S

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. 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 with a "C" or above; 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, simple circuits, electromagnetic waves, and geometrical wave optics. Lecture and laboratory.

Pre: MATH 122 with a "C" or above and PHYS 221 with a "C" or above. 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

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: 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 of 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 trans-

## PHYSICS

formations, 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.

To be taken concurrently with PHYS 467 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.

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

### 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

### 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 (1-3) Seminar

May be repeated for credit on each new topic.

Pre: Sr. standing Variable

### 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 435 and 436 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