PHYSICS

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

Also Required:
PHYS 212 Principles of Physics II (4)
PHYS 211 Principles of Physics I (4) AND
PHYS 222 General Physics II (5) OR
PHYS 221 General Physics I (5) AND
Choose one of the following sequences of introductory physics courses:
Required for Minor (14-16 credits):
MATH 121 Calculus I (4) MATH 122 Calculus II (4)
MATH 123 Calculus III (4)

Required Minor: None.

Required for Major (Core, 21 credits)
MATH 121 Calculus I (4)
MATH 122 Calculus II (4)
PHYS 221 General Physics I (5)
PHYS 222 General Physics II (5)
PHYS 331 Modern Physics I (3)
PHYS 332 Modern Physics II (3)
PHYS 441 Mechanics II (3)
PHYS 442 Electricity and Magnetism I (3)
PHYS 443 Electricity and Magnetism II (3)
PHYS 448 Optics (3)
PHYS 453 Quantum Mechanics I (4)
PHYS 454 Quantum Mechanics II (4)
PHYS 455 Advanced Laboratory (1)
PHYS 456 Advanced Laboratory (1)
PHYS 457 Undergraduate Research (2)

Polynomials/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 minorining 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 degree, provided they are completed before PHYS 221 (221). PHYS 482 counts only toward the BS minor.

Required Support Courses (8 credits):
MATH 121 Calculus I (4) MATH 122 Calculus II (4)

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 (53 credits):
MATH 121 Calculus I (4)
MATH 122 Calculus II (4)
PHYS 221 General Physics I (5)
PHYS 222 General Physics II (5)
PHYS 331 Modern Physics I (3)
PHYS 332 Modern Physics II (3)
PHYS 441 Mechanics II (3)
PHYS 442 Electricity and Magnetism I (3)
PHYS 443 Electricity and Magnetism II (3)
PHYS 447 Optics (3)
PHYS 453 Quantum Mechanics I (4)
PHYS 454 Quantum Mechanics II (4)
PHYS 455 Advanced Laboratory (1)
PHYS 456 Advanced Laboratory (1)
PHYS 457 Undergraduate Research (2)

Electives (Minimum of 8 Credits)*

*This is reduced to 6 credits if Physics 221 and 222 have been taken in place of PHYS 221 and 222 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.

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.

Pre: PHYS 211 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.

Pre: Either MATH 112 and 113, or MATH 115; and high school physics or PHYS 101 F, S
GE-2, 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

Pre: PHYS 212 or 222 and MATH 122 Variable

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-
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 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

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