

PHYSICS MS

PHYSICS EDUCATION MS

(DISCIPLINE-BASED)

College of Science, Engineering, & Technology
Department of Physics & Astronomy
141 Trafton Science Center N • 507-389-5743

Chair: Mark A. Pickar, Ph.D.
Graduate Coordinator: Youwen Xu, Ph.D.

Thomas Brown, Ph.D.; Paul Eskridge, Ph.D.; Robert Herickhoff, Ph.D.; Steven Kipp, Ph.D.; Igor Kogoutiuk, Ph.D.; Russell Palma, Ph.D.; Mark A. Pickar, Ph.D.; James Pierce, Ph.D.; Louis Schwartzkopf, Ph.D.; Hai-Sheng Wu, Ph.D.; Youwen Xu, Ph.D.

The Department of Physics and Astronomy presents several opportunities for study at the graduate level. The Master of Science is offered as the professional degree in physics. This degree is designed for students wishing to prepare themselves for doctoral study, or for work in a research/industrial position. A student may choose to emphasize the instrumentation area by including appropriate Electrical Engineering, Electronic Engineering Technology, or Computer Science courses. Students interested in teaching at a community college may elect the MS Community College track. Teacher certification is not required for this track.

The Master of Science in Physics Education is designed for individuals interested in strengthening their background in secondary school teaching. Previous teacher licensure is usually required.

Admission. Interested students should complete the general admission requirements of the College of Graduate Studies and Research.

Degree Completion. A graduate student in physics should complete a Plan of Study during the first part of the second semester, prior to the completion of the first 11 graduate credits of the program at Minnesota State University. This will require close consultation between the student and the initial advisor. The comprehensive written exam must be taken by the end of the second semester. A student cannot start his or her thesis research before passing the comprehensive written exam. Please contact the Department of Physics and Astronomy graduate coordinator for additional information.

Financial Assistance. The Department of Physics and Astronomy has a limited number of graduate assistantships available. Information and application materials can be obtained from the department graduate coordinator. Consult the front of this bulletin for more information on financial aid and graduate assistantships.

PHYSICS MS
(Thesis Plan Only - 30 credits)

Required Core (15-18 credits)

PHYS 607 Introduction to Research (2)

PHYS 641 Math Physics I (4)

PHYS 642 Math Physics II (4)

PHYS 692 Seminar (1-2) must be taken the first 2 spring semesters for a minimum of 2 credits

PHYS 699 Thesis (1-6), minimum 3 credits

Required Physics Electives (8-11 credits)

Choose any 500/600 level Physics elective courses approved by the student's advisor.

Required General Electives (4 credits)

Choose any 500/600 level elective courses approved by the student's advisor.

Additional Requirements:

A reading knowledge of a foreign language or a demonstrated ability in computer programming is required. Fifty percent of all courses must be taken at the 600 level. A written exam and a thesis and its oral defense are required.

COMMUNITY COLLEGE TRACK

(Thesis Plan - 30 credits)

(Alternate Plan Paper - 34 credits)

Required Physics Electives Core (9-17 credits)

PHYS 697 Internship (4-8)

In addition, choose any 500/600 level Physics elective courses approved by the student's advisor. Students who would like to have "internship" listed as "Internship in College Teaching" should contact the Graduate Dean.

Required Education Electives (minimum 6 credits)

KSP 625 Philosophy of Education in Historical Context (3)

KSP 670 Collegiate Institutions in the United States (3)

KSP 671 Learning and Teaching in Higher Education (3)

Required General Electives (6 credits)

Choose any 500/600 level elective courses from outside of physics and outside of professional education, approved by the student's advisor.

Required Research Methods (3 credits)

Choose a research methods course approved by the student's advisor.

Required Thesis or Alternate Plan Paper

PHYS 694 Alternate Plan Paper (1-2)

PHYS 699 Thesis (1-6) minimum 3 credits

Additional Requirements:

A reading knowledge of a foreign language or a demonstrated ability in computer programming is required. Fifty percent of all courses must be taken at the 600 level excluding the thesis or APP credits. A written exam is required. A thesis and its oral defense is required, if the thesis option is chosen.

PHYSICS EDUCATION MS

(DISCIPLINE-BASED)

(Thesis Plan - 30 credits)

(Alternate Plan Paper - 34 credits)

Teaching licensure is usually a prerequisite to pursuing this degree, since this degree does not lead to initial teaching licensure. Students who desire initial licensure should consult the Master of Arts in Teaching (MAT) program.

Required Physics Electives (9-17 credits)

Choose any 500/600 level elective courses approved by the student's advisor.

Required Education Electives (6 credits)

Choose any 500/600 level Education elective courses approved by the student's advisor from the following:

KSP 507, 605, 609, 612, 621, 625, 632, 640, 645, 654, 665, 666, 677, 681

EEC 520, 522, 602, 617, 631, 676

CSP 570

EDAD 652, 665

Required General Electives (6 credits)

Choose any 500/600 level elective courses approved by the student's advisor.

Required Research Methods (3 credits)

Choose a research methods course approved by the student's advisor.

Required Thesis or Alternate Plan Paper

PHYS 694 Alternate Plan Paper (1-2)

PHYS 699 Thesis (1-6) minimum 3 credits

Additional Requirements:

Fifty percent of all courses must be taken at the 600 level excluding the thesis or APP credits. A written exam is required. A thesis and its oral defense is required, if the thesis option is chosen.

COURSE DESCRIPTIONS

PHYSICS

PHYSICS

PHYS 504 (2) Physics & Society

Relations between physics and other intellectual communities: e.g., philosophy, humanities, social sciences, the arts.

(V) Prerequisite: consent

PHYS 517 (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.

(V) Prerequisite: PHYS 212 or 222 and MATH 122

PHYS 535 (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, and one-electron atoms. X-ray and optical excitation of multielectron atoms. Lecture and laboratory.

(S) Prerequisite: PHYS 212 or 222 and MATH 122

PHYS 536 (3) Modern Physics II

Topics include the nuclear force, interactions of nuclear particles with matter, radioactive decay, nuclear structure, nuclear reactions, fusion, fission, elementary particles, and the quark model. Lecture and laboratory.

(F) Prerequisite: PHYS 435/535

PHYS 541 (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.

(F) Prerequisite: PHYS 212 or 222 and MATH 223 and 321

PHYS 547 (3) Electricity & Magnetism I

Electrostatic fields, magnetostatic fields, steady currents, electromagnetic induction. Review of vector algebra.

(F) Prerequisite: PHYS 212 or 222 and MATH 223, 321, or 422

PHYS 548 (3) Electricity & Magnetism II

Electromagnetic waves, propagation and radiation of waves, and electrodynamics and relativity.

(S) Prerequisite: PHYS 447 or 547

PHYS 553 (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.

(S) (of odd calendar years) Prerequisite: PHYS 435 or 535

PHYS 557 (3) Optics

Geometric optics, wave optics, properties of light and matter, optics of transformations, and quantum optics. Lecture and laboratory.

(S) (of odd calendar years) Prerequisite: PHYS 222 and MATH 122

PHYS 561 (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.

(F) Prerequisite: PHYS 435/535, 441/541, and MATH 321

PHYS 565 (3) Computer Applications in Physics

Numerical solutions of physics problems and computer simulations of physical systems. Lecture and laboratory.

(F) Prerequisite: PHYS 212 or 222, and MATH 122, and familiarity with some programming language, or consent

PHYS 567 (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 575.

(F) Prerequisite: PHYS 435/535 and 453/553

PHYS 568 (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 580.

(F) Prerequisite: PHYS 467/567

PHYS 573 (3) Statistical Physics

Statistical mechanics, kinetic theory, thermodynamics.

(S) (of even calendar years) Prerequisite: PHYS 212 or 222 and MATH 223 and 321

PHYS 575 (2) Advanced Laboratory

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

(S) Prerequisite: PHYS 436 or 536 or consent

PHYS 580 (2) Laboratory 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.

(F,S,SS) Prerequisite: PHYS 101

PHYS 582 (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 university. May not count as a physics elective.

(S) Prerequisite: one year of chemistry and one year of physics or consent

PHYS 584 (2) Middle/Junior High Science Teaching

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

(V) Prerequisite: majority of required courses completed or consent

PHYS 590 (2-4) Workshop

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

(V)

PHYS 591 (1-8) In-Service

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

(V)

PHYS 595 (1-3) Selected Topics

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

(V)

PHYS 607 (2) Intro to Research

Use of the library, electronic and machine shop practices, vacuum and cryogenic techniques, research interests of faculty.

(F)

PHYS 641 (4) Mathematical Physics I

Vector and tensor analysis; coordinate systems; determinants, matrices, and group theory; infinite series; functions of a complex variable.

(F)

PHYS 642 (4) Mathematical Physics II

Differential equations; Sturm-Liouville theory; Bessel, Legendre, and other special functions; Fourier series; integral transforms; integral equations; calculus of variations.

(S) Prerequisite: PHYS 641

PHYS 675 (1-4) Selected Topics

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

(V)

PHYS 677 (1-4) Individual Study

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

(V)

PHYS 680 (1) Curriculum Study in Physics

Presentation and discussion of curricular developments.

(V)

PHYS 681 (2) Demonstration in Physics

Materials, techniques, and procedures.

(V)

PHYS 691 (1-4) In-Service

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

(V)

PHYS 692 (1-2) Seminar

May be repeated for credit on each new topic.

(V)

PHYS 694 (1-2) Alternate Plan Paper

(V)

PHYS 695 (1-6) Research

(V)

PHYS 696 (1-2) Independent Reading

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

(V)

PHYS 698 (1-8) Internship

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

(V)

PHYS 699 (1-6) Thesis

(V)

ASTRONOMY

AST 520 (3) Stellar Astrophysics

Blackbody radiation; radiative transfer; atomic structure; spectroscopic notation; excitation; ionization; absorption and emission coefficients; line profiles; analysis of stellar spectra.

(ALT-F) Prerequisite: AST 225 and PHYS 222

AST 521 (3) Stellar Structure

The gaseous state; degenerate matter; equations of stellar structure; polytropes; models of stellar interiors and atmospheres; stellar evolution; nucleosynthesis; stellar endpoints.

(ALT-S) Prerequisite: AST 520

AST 530 (3) Galactic Structure

Structure, kinematics, and dynamics of our galaxy.

(ALT-F) Prerequisite AST 225, PHYS 222, and MATH 223

AST 531 (3) Extragalactic Astronomy

Normal galaxies; groups and clusters of galaxies; galaxy interactions and mergers; active galactic nuclei; large-scale structure; galaxy formation and evolution; cosmology.

(ALT-S) Prerequisite: AST 530

AST 591 (1-6) In-Service

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

(V)

AST 594 (1-6) Workshop

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

(V) Prerequisite: consent

AST 595 (1-4) Selected Topics

AST 677 (1-6) Individual Study

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

(V) Prerequisite: consent

AST 691 (1-6) In-Service

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

(V) Prerequisite: consent

AST 694 (1-2) Alternate Plan Paper

(V) Prerequisite: consent

AST 695 (1-6) Research

Students will conduct supervised research in astronomy.

(V) Prerequisite: consent