HP 698 (1-10) Internship
Supervised field experience related to the student's academic specialization associated with the disciplines of human performance. Disciplines include the following: College Teaching, Sport Management, Public School Teaching, D/APE, Intramural-Recreational Sports Management, Elementary Physical Education, Exercise Physiology, and Sport Psychology.
Prerequisite: grad. student/professor consent

HP 699 (1-4) Thesis
Course requires completion of thesis paper. Prerequisite: grad. student/professor consent

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 Pickar, Ph.D.
Graduate Coordinator: Youwen Xu, Ph.D.

Paul Eskridge, Ph.D.; Robert Herickhoff, Ph.D.; Steven Kipp, Ph.D.; Igor Kogoutiouk, Ph.D.; Mark 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 (12-15 credits)
PHYS 607 Intro. to Research (2)
PHYS 641 Math Physics I (4)
PHYS 642 Math Physics II (4)
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 (7 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

PHYS 504 (2) Physics & Society
Relations between physics and other intellectual communities: e.g., philosophy, humanities, social sciences, the arts.
V Prerequisite: con

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. Molecular spectra.
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.
F Prerequisite: PHYS 435/535

PHYS 539 (4) Electronics for Physics

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 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 212 or 222 and MATH 122

PHYS 557 (3) Optics
Geometric optics, wave optics, properties of light and matter, optics of transformations, and quantum optics.
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. Interfacing computers with scientific equipment for experiment control, data acquisition, and data analysis.
F Prerequisite: PHYS 212 or 222 and familiarity with some programming language, or con

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 con

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 con

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 con

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

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. AST 225 and PHYS 222 ALT-F

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. AST 520 ALT-S

AST 530 (3) Galactic Structure
Structure, kinematics, and dynamics of our galaxy.
AST 225, PHYS 222, MATH 223, and COMS 272 ALT-F

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. AST-530 ALT-S

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 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 consent

AST 691 (1-6) In-Service
A course designed to upgrade the qualifications of persons on-the-job.
V consent

AST 694 (1-2) Alternate Plan Paper
V consent

POLITICAL SCIENCE MA

PUBLIC ADMINISTRATION MA

PUBLIC ADMINISTRATION/URBAN & REGIONAL STUDIES (JOINT) MA

College of Social and Behavioral Sciences
Department of Political Science
109 Morris Hall • 507-389-2721

Chair: Doran Hunter, Ph.D.
Graduate Coordinator: John Parham, Ph.D.

Abdalla Battah, Ph.D.; Jeff Bumgarner, Ph.D.; Sue Burum, J.D.; Doran Hunter, Ph.D.; Tom Inglot, Ph.D.; Avra Johnson, Ph.D.; Joe Kunkel, Ph.D.; John Parham, Ph.D.; Mark Robbins, Ph.D.; Carolyn Shrewsbury, Ph.D.; Fred Slocum, Ph.D.; Jackie Vieceli, Ph.D.

Political Science, with its well-balanced curriculum and diverse and experienced faculty, offers two graduate programs for students pursuing academic and professional interests dealing with public policy questions and issues. The Department of Political Science offers Master of Arts and Master of Arts in Public Administration degrees. The Department of Political Science also collaborates with the Institute of Urban and Regional Studies to offer the Joint Program in Public Administration and Urban Studies.

Graduates of these programs are successfully pursuing a variety of challenging careers. Many occupy important positions with federal, state or local units of government. Others who have gone on to receive doctorates are teaching political science at colleges and universities, consulting, or doing policy analysis with large businesses and organizations. A large number are working in private enterprises, and several have pursued successful careers in practical and electoral politics.

Admission. The GRE is not required for admission to any of these programs.

POLITICAL SCIENCE, MA
(Thesis Plan - 34 credits)
(Alternate Plan Paper - 34 credits)

The Master of Arts in Political Science (MAPS) is intended both for those who desire to eventually pursue a Ph.D. in Political Science and those who desire a terminal degree. The MAPS is primarily a generalist degree in political science which also provides a wide range of possibilities for specialization or for interdisciplinary work. The student, in consultation with a faculty advisor, plans a program of study reflecting the student's specific interests.

Admission Requirements for the MAPS (Master of Arts in Political Science) are:
1. An undergraduate GPA of at least 3.0 on a 4.0 scale;
2. A baccalaureate degree from an accredited college or university;
3. At least 9 credits of undergraduate political science coursework. The requirement for 9 credits of undergraduate political science courses may be waived if the applicant can show relevant work related or other experiences that provide the necessary background to pursue graduate work in political science; and
4. When students do not meet the normal admission requirements, they may be recommended for admission by the department subject to removal of deficiencies or other conditions.

Required Core (7 credits)
POL 600 Research Methods (3)
POL 611 Orientation for Graduate Students (1)
POL 650 Seminar: Political Theory (3)
A minimum of 12 of the remaining credits must be Political Science.

Required Electives (maximum 21 -26 credits)
Choose any 500/600 level elective courses selected in consultation with an advisor.

Required Written Comprehensive and Oral Exams

Required Thesis or Alternate Plan Paper
POL 694 Alternate Plan Paper (1-2)
POL 699 Thesis (3-6)

At least 17 of the 34 credits must be in 600 level classes. A research tool of either a reading knowledge of a foreign language or an advanced statistics or other advanced research course is required but does not count toward the 34 credits required for the MAPS. The research tool must be approved by the student's committee.

PUBLIC ADMINISTRATION MA
(Thesis Plan - 34 credits)
(Alternate Paper Plan - 34 credits)

This program is designed for persons already in or preparing to enter public service. The program is designed to enable the student to perform management or staff functions in such areas as finance, budget analysis and personnel management. Students are prepared with a knowledge of political and legal processes of government and with an appreciation for managerial decision-making skills required by public agencies. MAPA students may choose between the Thesis Plan and the Alternate Plan. The Thesis Plan requires 34 credits (including credits taken for the thesis, but not including the research tool). The Alternate Plan requires 34 (not including the research tool) credits along with the submission of an alternate plan paper written as a part of the requirements of a designated course. For either plan, 18 credits of core courses are required.

Admission Requirements for the MAPA
(Master of Arts in Public Administration) are:
1. A minimum GPA of 3.0 on a 4.0 scale for the last 2 years of undergraduate coursework, OR; By using other factors (e.g. promising public or private sector work experience), demonstrate that the program can be successfully completed; and
2. A baccalaureate degree from an accredited college or university; and
3. All students need a reasonable background knowledge in government and quantitative methods. In some cases, the student's advisor may require that knowledge and skill deficiencies be remedied.

Required Core (18 credits)
POL 600 Research Methods (3)
POL 606 Organization Theory (3)
POL 622 Seminar: Theory & Pract. Public Administration (3)