Physics

In the College of Sciences

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Faculty

Roger A. Lilly, Ph.D., Professor of Physics, Chair of Department

Lowell J. Burnett, Ph.D., Professor of Physics

Jeffrey A. Davis, Ph.D., Professor of Physics, Director of Electro-Optics Program

Fred M. Goldberg, Ph.D., Professor of Physics

Richard H. Morris, Ph.D., Professor of Physics

Saul B. Oseroff, Ph.D., Professor of Physics

Patrick J. Papin, Ph.D., Professor of Physics, Director and Graduate Adviser for Radiological Health Physics

Robert J. Piserchio, Ph.D., Professor of Physics

Donald E. Rehfuss, Ph.D., Professor of Physics

Stephen B. W. Roeder, Ph.D., Professor of Physics and Chemistry

Herbert B. Shore, Ph.D., Professor of Physics

Alan R. Sweedler, Ph.D., Professor of Physics, Director of Center for Energy Studies

Jacques D. Templin, Ph.D., Professor of Physics (Graduate Adviser)

Milton S. Torikachvili, Ph.D., Professor of Physics

William J. Wallace, Ph.D., Associate Professor of Physics

Massimo Boninsegni, Ph.D., Assistant Professor of Physics

Associateships

Graduate teaching associateships in physics are available to a limited number of qualified students. Application blanks and additional information may be secured from the chair of the department.

General Information

The Department of Physics offers graduate study leading to the Master of Arts degree in physics, the Master of Science degree in physics, and the Master of Science degree in radiological health physics.

The Master of Arts degree emphasizes broad training and intensive coursework. This is a non-thesis program designed to lead the student to a comprehensive final examination. Specific courses, in both pure and applied physics, are chosen to complement the background of the individual student and achieve the desired educational goals.

The Master of Science degree emphasizes research experience in a chosen specialty. It is designed to augment the student's undergraduate training with a core curriculum of advanced courses, then followed by a period of research and preparation of a thesis. Thesis topics are encouraged in both pure and applied areas of physics.

Modern experimental laboratories are available for student and faculty research in the areas of acoustics, modern optics, holography, optical properties of solids, laser physics, solid-state physics, nuclear magnetic resonance, electron paramagnetic resonance, atomic physics, solar energy, nuclear, medical and health physics, microprocessor instrumentation, and image processing. Theoretical programs are available in condensed matter physics, electricity and magnetism, laser physics, gravitation, relativity, and mathematical physics.

The Master of Science degree in radiological health physics is designed to train health physicists in the use of radioactive materials and radiation-producing devices such as those used in hospitals and related medical facilities, colleges and universities, industry, public health services, nuclear power installations, the military, the Department of Energy, the Environmental Protection Agency, and the Nuclear Regulatory Commission. The program emphasizes techniques of radiation dosimetry, and instrumentation in addition to the fundamental physics of radiation production and protection.

Master of Arts and Master of Science Degrees in Physics

Admission to Graduate Study

All students must satisfy the general requirements for admission to the University with classified graduate standing, as described in Part Two of this bulletin. In addition, the undergraduate preparation in physics must have substantially satisfied the undergraduate requirements for the bachelor's degree in physics. (Refer to the General Catalog for a description of these majors.) If the student's undergraduate preparation is deficient, he/she will be required to take courses for the removal of the deficiency. These courses are in addition to the minimum of 30 units for the master's degree.

Advancement to Candidacy

All students must satisfy the general requirements for advancement to candidacy, as stated in Part Two of this bulletin.

Specific Requirements for the Master of Arts Degree in Physics

(Major Code: 19021)

In addition to meeting the requirements for classified graduate standing, the student must satisfy the basic requirements for the master's degree as described in Part Two of this bulletin. The student's graduate program must include Physics 604A-604B, 608, and 610A-610B. Fifteen additional units of 500-, 600- or 700-numbered electives must be selected with the approval of the Physics Department graduate adviser. Physics 606 is recommended. The Master of Arts degree in physics requires the completion of Plan B, a comprehensive written examination.

Specific Requirements for the Master of Science Degree in Physics

(Major Code: 19021)

In addition to meeting the requirements for classified graduate standing, the student must satisfy the basic requirements for the master's degree as described in Part Two of this bulletin.

The student must complete a graduate program to include Physics 604A-604B, 608, 610A, 797 (3 units) and 799A. Twelve additional units of 500-, 600-, or 700-numbered electives must be selected with the approval of the Physics Department graduate adviser. The student is required to pass a final oral examination on the thesis.

Master of Science Degree in Radiological Health Physics

Admission to Graduate Study

All students must satisfy the general requirements for admission to the Graduate Division with classified graduate standing, as described in Part Two of this bulletin under Admission to the Graduate Division. In addition, the undergraduate preparation in biology, chemistry, mathematics, and physics must have substantially satisfied the undergraduate requirements for a baccalaureate degree in the life sciences or the physical sciences so that satisfactory progress can be made toward the master's degree. If the student's undergraduate preparation is deficient, he will be required to take courses for the removal of the deficiency. These courses are in addition to the minimum of 30 units for the master's degree.

Advancement to Candidacy

All students must satisfy the general requirements for advancement to candidacy, as described in Part Two of this bulletin.

Specific Requirements for the Master of Science Degree in Radiological Health Physics

(Major Code: 12251)

In addition to meeting the requirements for classified graduate standing and the basic requirements for the master's degree as described in Part Two of this bulletin, the student must meet the following requirements:

1. Have completed an approved program of 30 units of which at least 15 units must be in the 600- and 700-numbered courses and which includes the following:

	Units
Biology 561 Radiation Biology	3
Physics 560 Radiological Physics and Dosimetry	3
Physics 561 Nuclear Instrumentation	3
Physics 564 Nuclear and Elementary Particle Physics	3
Physics 660 Radiological Health Physics	3
Physics 661 Advanced Nuclear Instrumentation	3
Physics 662 Colloquium in Radiological Sciences	1
Total units	19

   The remaining eleven units must be selected from 500-, 600- or 700-numbered courses with the approval of the graduate adviser.
2. The thesis option (Plan A) requires the approval of the graduate adviser. Students in Plan A must include Physics 797 and Physics 799A in the 30-unit program, and are required to pass a final oral examination on the thesis. Students in Plan B (non-thesis option) are required to pass a comprehensive written examination.

Courses Acceptable on Master's Degree Programs in Physics

UPPER DIVISION COURSES

510. Quantum Mechanics (3)
Prerequisites: Physics 350, 354B, and Mathematics 342B.
Mathematical and physical foundations of quantum theory in terms of wave and matrix mechanics. Applications to properties of atoms and solids.

513. Electronic Instrumentation (3)
One lecture and six hours of laboratory.
Prerequisites: Physics 311. Recommended: Credit or concurrent registration in Physics 516.
Computer data acquisition and control, modern signal detection and enhancement techniques; transducer principles and applications; noise and the enhancement of the signal-to-noise ratio.

516. Theory of Scientific Instrumentation (3)
Prerequisites: Physics 311 and Mathematics 342B.
Fourier analysis with applications to scientific instrumentation, spectroscopy, and image processing; Z transforms and digital filtering; detection systems and their optimization of the signal-to-noise ratio.

532. Solid State Physics (3)
Prerequisites: Physics 350, 354B, and Mathematics 342B.
Elastic, thermal, electric, magnetic and optical properties of solids. Introduction to the energy band theory of solids, with applications to semiconductors and metals.

533. Experimental Techniques in Condensed Matter Physics (3)
One lecture and six hours of laboratory.
Prerequisites: Physics 357 and credit or concurrent registration in Physics 532.
Experiments in various fields of condensed matter such as x-ray diffraction, Hall effect, superconductivity, and electron paramagnetic resonance.

534. Colloquium in Condensed Matter Physics (1) Cr/NC
Prerequisite: Credit or concurrent registration in Physics 532.
Student and faculty research project presentations. Maximum credit three units.

542. Acoustics (3)
Prerequisites: Physics 350 and Mathematics 342B.
Wave motion, production, reception, transmission and analysis of sound. Special applications such as environmental noise, underwater and seismic waves.

552. Modern Optics and Lasers (3)

Prerequisites: Physics 406 with minimum grade of C; credit or concurrent registration in Physics 400B; Mathematics 342B.

Electromagnetic theory, matrix methods of optics, propagation of Gaussian beams, optical resonators, interaction of radiation and atomic systems, theory of laser oscillation, nonlinear optics, specific laser systems, optical detectors, applications of lasers in physics.

553. Modern Optics Laboratory (3)

One lecture and six hours of laboratory.

Prerequisites: Physics 357 with minimum grade of C; Physics 406 with minimum grade of C; credit or concurrent registration in Physics 552.

Experiments in various fields of modern optics such as holography, physics of lasers, Fourier transform spectroscopy, Raman spectroscopy, light modulation techniques, fiber optics, spatial filtering, diffraction grating spectroscopy, radiometry, and nonlinear optics.

554. Colloquium in Optics Research (1) Cr/NC

Prerequisites: Concurrent registration in Physics 498A or 498B or 797 and consent of instructor.

Student and faculty research project presentations. Maximum credit three units.

560. Radiological Physics and Dosimetry (3)

Prerequisite: Credit or concurrent registration in Physics 354A.

Ionizing radiation fields, interactions of radiation with matter, cavity theory, external radiation dosimetry.

561. Nuclear Instrumentation (3)

Two lectures and three hours of laboratory.

Prerequisites: Credit or concurrent registration in Physics 311 and 560.

Electronics of nuclear instrumentation. Radiation detection and measurement using ionization chambers, GM and proportional counters, and scintillation dosimetry.

564. Nuclear and Elementary Particle Physics (3)

Prerequisite: Physics 354B.

Nuclear and elementary particle phenomena including nuclear structure of reactions, nuclear devices, elementary particle symmetry and structure, and experimental methods.

570. Relativity (3)

Prerequisites: Physics 354A, 400B, and Mathematics 342B.

Relative coordinates, Lorentz transformation, covariant formation of the laws of physics, applications of special relativity, introduction to curved space time, cosmology.

580. Computational Physics (3)

Prerequisites: Physics 354B, Computer Science 106, Mathematics 342B, credit or concurrent registration in Physics 400A.

Computer programming for numerical solution of problems in classical mechanics, electromagnetism, optics, and quantum mechanics. Use of Fortran and C programming languages and the UNIX operating system. Incorporation of standard subroutines for linear algebra and differential equations into student written programs.

596. Special Topics in Physics (1-4)

Prerequisite: Consent of instructor.

Selected topics in classical and modern physics. May be repeated with the consent of the instructor. See Class Schedule for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree. Maximum credit of six units of 596 applicable to a bachelor's degree. Maximum combined credit of six units of 596 and 696 applicable to a 30-unit master's degree.

GRADUATE COURSES

600. Seminar (1-3)

Prerequisite: Consent of instructor.

An intensive study in advanced physics. May be repeated with new content. See Class Schedule for specific content. Maximum credit six units applicable to a master's degree.

602A-602B. Mathematics of Physics (3-3)

Prerequisite: Mathematics 342B. Physics 602A is prerequisite to 602B.

Topics from matrix theory, vector and tensor analysis, orthogonal function theory, calculus of variations and probability theory with particular emphasis on applications to physical theory.

604A-604B. Electromagnetic Theory (3-3)

Prerequisite: Physics 400B. Physics 604A is prerequisite to 604B.

Boundary value problems; time varying electric and magnetic fields; propagation of radiation; antennas, wave guides.

606. Statistical Mechanics (3)

Prerequisites: Physics 460 and 510.

Classical and quantum statistics, kinetic theory, low-pressure phenomena, Boltzmann transport equation, irreversible processes.

608. Classical Mechanics (3)

Prerequisite: Physics 350.

Vector and tensor methods, motion of rigid bodies, vibration, coupled circuits, Lagrange's and Hamilton's equations, principle of least action.

610A-610B. Quantum Mechanics (3-3)

Prerequisite: Physics 510.

Physical and mathematical basis of quantum mechanics. Wave mechanics and the Schroedinger Equation, matricies and Hilbert space, angular momentum and spin, atomic structure, bound-state perturbation theory, many particle systems, transition rates and time-dependent perturbation theory, scattering, and relativistic quantum mechanics.

632. Theory of the Solid State (3)

Prerequisites: Physics 510 and 532.

The band theory of solids, with applications to the electrical and optical properties of dielectrics, semiconductors and metals.

652. Advanced Optics (3)

Prerequisite: Physics 552.

Selected topics in advanced optics such as rigorous diffraction theory, optical spectra, lasers, nonlinear optics and applications of Fourier analysis to optical systems and information processing.

654. Gravitation (3)
Prerequisite: Physics 570.
Differential geometry, metric geodesies. Equivalence principle, collapsed objects, black holes, gravitational waves, evolution of the universe.

660. Radiological Health Physics (3)
Prerequisite: Physics 560.
Radiation protection guides, internal, and external radiation protection and dosimetry. Radiological risk assessment.

661. Advanced Nuclear Instrumentation (3)
One lecture and six hours of laboratory.
Prerequisite: Physics 561.
Continuation of Physics 561. Radiation detection and measurement using scintillation and thermoluminescence dosimetry, semiconductor detectors, and neutron dosimetry.

662. Colloquium in Radiological Sciences (1) Cr/NC
Prerequisite: Consent of instructor.
Joint critical study by students and faculty of the fields of knowledge pertaining to radiological sciences. Periodic contributions are made by visiting scientists. Research in progress is discussed. May be repeated with new content. Maximum credit two units applicable to a master's degree.

670. Medical Health Physics (2)
Prerequisites: Physics 660 and 661.
Radiation protection and dosimetry in medical environments including diagnostic radiology, nuclear medicine, and radiation oncology.

797. Research (1-3) Cr/NC/SP
Prerequisite: Consent of graduate adviser.
Research in one of the fields of physics. Maximum credit six units applicable to a master's degree.

798. Special Study (1-3) Cr/NC/SP
Prerequisite: Consent of staff; to be arranged with department chair and instructor.
Individual study. Maximum credit six units applicable to a master's degree.

799A. Thesis (3) Cr/NC/SP
Prerequisites: An officially appointed thesis committee and advancement to candidacy.
Preparation of a thesis in physics for the master's degree.

799B. Thesis Extension (0) Cr/NC
Prerequisite: Prior registration in Thesis 799A with an assigned grade symbol of SP.
Registration required in any semester or term following assignment of SP in Course 799A in which the student expects to use the facilities and resources of the university; also student must be registered in the course when the completed thesis is granted final approval.