equilibrium thermodynamics will also be presented.

CHM 5480C Quantum Chemistry (3) Prereq: One year of calculus based physical chemistry or consent of the department. The purpose of the course is to develop in the student an understanding of the fundamentals of quantum mechanics and to use those fundamentals as the basis for understanding the electronic structure of atoms and molecules and, in particular, the bonding structure of molecules. A level of mathematics rigor including the use of differential equations and vector analysis will be required for dealing with the material.

CHM 5490C Chemical Spectroscopy (3) Prereq: Quantum chemistry. An introduction to the relationships among quantum mechanical formulations, experimentally determinable quantities obtained via spectroscopic methods and physical parameters related to the structure of molecular systems. The main scope of the course will be devoted to an in-depth development of relations for elementary systems.

CHM 5531C X-Ray Crystallography (3) Prereq: Inorganic chemistry principles. An introductory treatment of the principles and basic laws of crystallography. These laws and principles will be used to solve molecular structures from x-ray diffraction data.

CHM 5540C Chemical Application of Group Theory (3) Prereq: Admission to graduate program. A detailed treatment of the principles of group theory and their applications to quantum mechanics and spectra of molecules.

CHM 5610C Inorganic Chemistry Principles (3) Prereq: One semester of undergraduate inorganic chemistry or consent of the department. Atomic structure, term symbols, modern bonding theories, acid-base chemistry, coordination chemistry, chemical reactions and mechanisms.

CHM 5650C Structural Methods in Inorganic Chemistry (3) Prereq: Inorganic chemistry principles. A brief introductory treatment of group theory presentation of modern structural techniques applicable to elucidation of inorganic molecules as revealed through spectroscopic methods.

CHIS 5610C Environmental Chemistry (3) Methods of sampling, detection monitoring, and analysis for chemical pollutants in the air, in the water environment, and in food and drugs; chemical technology's role in solid waste management; introduction to environmental laws.

CHM 5931C Special Topics (3 to 6) Prereq: Consent of the department. Coverage of selected topics, concepts and theoretical principles at the graduate level of organic chemistry, biochemistry, physical chemistry, analytical chemistry and/or inorganic chemistry. Coverage of subject matter is tailored to the needs and interests of the graduate student.

CHM 5942C Chemistry Laboratory Supervision and Instruction (3 to 6) Prereq: Consent of the department. Strong emphasis is placed on theoretical principles of undergraduate chemistry and pedagogy and reinforced with graduate student teaching of a chemistry laboratory course under faculty supervision.

CHM 5971C Graduate Thesis in Chemistry (6-9) Prereq: Completion of core courses or consent of department. Students will conduct independent research investigations in the area of their specific interest under the direction and supervision of a graduate faculty member. Upon completion of the research investigation, each student must submit a thesis in the acceptable format to his or her graduate committee and successfully defend the thesis in an oral presentation.

CHM 6935 Graduate Chemistry Seminar (1) Oral presentations on selected topics in the field of chemistry. Each graduate student is required to present one seminar in his or her area of specialization according to departmental standards.

Master of Science in Physics

The Florida A&M University (FAMU) Department of Physics, in the College of Arts and Sciences, offers a program of study leading to a master of science in physics degree. This program is designed to provide a solid foundation in physics courses work (beyond the baccalaureate level) and research essential for pursuing doctoral studies in physics or related academic areas. The successful student will be prepared to enter the work force, or enter a high quality Ph.D. program. The M.S. program is also designed to facilitate research that will significantly contribute to the understanding of the physical universe.

The student may choose either a thesis or non-thesis program leading to the master of science in physics degree. The specialization area are: (1) experimental high energy and nuclear physics, (2) experimental fluid dynamics and plasma physics, (3) computational physics, (4) molecular physics, (5) quantum chemistry, (6) astrophysics, (7) experimental condensed matter physics, and (8) accelerator and laser physics.

Admission

Admission to the master of science in physics program is in conformity with the uniform requirements that the Board of Regents has established for the entire State University System of Florida. These include:

1. A 3.0 (on a scale of 4.0) cumulative grade point average covering the last six semester hours of undergraduate preparation, or a combined score of 1000 on the Verbal and Quantitative Sections of the Aptitude Test of the Graduate Record Examination must be achieved;

2. The possession of a baccalaureate degree from an accredited institution of higher education;

3. Acceptance of undergraduate seniors into the master of science program is conditional upon their completion of all requirements for the baccalaureate degree before commencement of graduate studies;

4. In addition, other factors such as motivation, attitude, and potential for successful graduate work will be considered. These factors will be judged from at least two letters of recommendation from undergraduate physics instructors and/or personal interviews. Conditional acceptance into the graduate program may be granted as a result of these letters or interview when requirement 2 is not met. However, a student may not remain in the program for more than one semester with a conditional acceptance;

5. Foreign students whose native language is not English, must make a score of at least 550 on the TOEFL (Test of English as a foreign language).

Academic Requirements

The requirements consist of a set of core requirements and then separate requirements for the thesis and non-thesis programs:

Core Requirements

1. Completion of 24 semester hours of the core curriculum which consists of:
   - PHY 6246, 6247 Classical Dynamics I and Classical Dynamics II
   - PHY 6346, 6347 Electrodynamics I and Electrodynamics II
   - PHY 6524 Quantum Statistical Mechanics
   - PHY 6645, 6646 Quantum Mechanics I and Quantum Mechanics II
   - PHZ 6115 Mathematical Methods for Physics I
   These courses must be completed with at least a 3.0 grade point average (GPA);

2. A grade of 3.0 (out of 4.0) must be made on the departmental proficiency examination. This exam consists of a written examination given twice per year covering the content of an undergraduate program in basic physics. All first-year graduate students must take the exam before or during their second semester of graduate study;

3. After completion of the requirements for a thesis or non-thesis program, the degree candidate shall be required to pass an oral examination of the master of science in physics core course work. The exam shall be given by the candidate's graduate committee which shall consist of four physics faculty members. If the student has completed a thesis, one committee member will be the candidate's thesis advisor and the exam will also include a defense of the thesis. If the candidate is not a thesis student, the exam may also cover additional coursework. The additional courses to be covered will be communicated by the committee to the student at least one month prior to the examination;

4. Every candidate is required to teach at least one undergraduate laboratory for one semester (PHY 6110).

Additional Non-Thesis Requirements

1. In addition to the 24 semester hours of core curriculum, 12 semester hours must be taken from Physics courses numbered 5000 and above with at least 9 taken on a letter grade basis.

Additional Thesis Requirements

1. In addition to the 24 semester hours of core curriculum, 9 semester hours must be taken from Physics courses numbered 5000 and above
with at least 6 semester hours taken on a letter grade basis.
2. The candidate must submit a thesis which is accepted by the thesis
advisor and the thesis committee. Acceptance is given by way of sig-
nature.
3. No more than 3 semester hours of PHY 6918 credit and 3 semester
hours of PHY 6110 credit may be counted toward the master of sci-
ence in physics degree.
4. At least 3 semester hours of thesis credit (PHY 5971r) must be passed.

Doctor of Philosophy in Physics

The Florida A&M University (FAMU) Department of Physics, in the
College of Arts and Sciences, offers a program of study leading to
the doctor of philosophy in physics degree. The primary objective of
the doctorate program in physics is to provide talented graduate stu-
dents with a rigorous academic environment in which to conduct
research and to develop the analytical, empirical, and leadership skills
required for mathematical, scientific and technological careers. The
program’s specific goals focus on producing research physicists of the
highest caliber.

The design of the Ph.D. program is such that it will complement the
ongoing research at FAMU. The areas of specialty include: (1) exper-
imental high energy and nuclear physics, (2) experimental fluid
ynamics and plasma physics, (3) computational physics, (4) molecu-
lar physics, (5) quantum chemistry, (6) astrophysics, (7) experimental
condensed matter physics, and (8) accelerator and laser physics.

Admission

Admission to the Doctorate of Philosophy in Physics program is
granted in conformity with the uniform requirements established by
the State University System of Florida. These include: (1) the posses-
sion of a bachelor and/or master of science in physics degree from an
accredited institution of higher education. Official academic trans-
cripts are required; (2) a GPA of 3.0 on a scale of 4.0 covering the
last 60 Semester Hours of undergraduate preparation and/or a GPA of
3.0 on all graduate work attempted, or a combined score of 1000 on the
Verbal and Quantitative sections of the Graduate Record Exam; (3)
have received two (2) strong letters of support from undergraduate or
graduate student whose native language is not English, must make a score of at least 550 on the TOEFL.

Academic Requirements

A full-time student in the doctoral graduate program will take
nine credit hour each Fall, Spring, and Summer term. A maximum of
90 credit hours or 72 hours for the minimum FAMU residency require-
ment and 18 hours of dissertation research activities is required for the
Ph.D. in Physics. The average time to complete the physics doctorate
is five years.

Admission with a Bachelor of Science Degree

(1) Student will take the advanced graduate laboratory and five (5) elective
courses.
(2) Student will take written qualifying exam at the end of first year.
(3) Student will take additional elective courses to expand his/her knowl-
edge in chosen specialty in the second year.
(4) Student will be required to successfully complete the Ph.D. candidacy
or "A" exam after completing courses with a GPA of 3.00 or higher.
(5) Student must demonstrate proficiency in graduate-level classical
mechanics, electrodynamics, and quantum mechanics in order to pass
the candidacy exam.

Admission with a Master of Science Degree

(1) Student will be given the option of either writing the qualifying exam
immediately upon entering the program or spending a year taking sup-
plementary course work.
(2) Student will then join the Ph.D. program, after passing the qualifying
exam, M.S. at the second-year level.

(3) Each student, after passing the "A" exam, will then begin thesis research
supervised by a faculty member.
(4) The student, upon successful completion of research, will then be
required to take the "B" exam on his or her written dissertation.
(5) The oral defense will be conducted by a committee of three physics
faculty: the research advisor and two faculty from different research
specialties.

Course Descriptions

- PHY 5909r Directed Individual Study (1-12): Individual study directed
  by graduate faculty on a topic of mutual student and faculty interest.
- PHY 5920r Colloquium (1) Physics colloquia as scheduled.
- PHY 5971r Thesis (3-6) Course to be taken while preparing the
  Master’s thesis-supervised by the thesis advisor.
- PHY 6110 Supervised Teaching (1-6): Supervised teaching practicum
  for physics graduate students. Individual assignments will be given in
  either the General Physics Lab, General Physics Recitation and/or College
  Physics Lab.
- PHY 6157 Computation Physics (3): Computational methods of theo-
  retical physics with applications to atomic, molecular, condensed matter,
  and many body physics.
- PHY 6246 Classical Dynamics-I (3): Lagrange’s and Hamilton’s
  equations of motion, variational methods, symmetry, kinematics and
dynamics of rigid body motion, special relativity, canonical variables and
  transformations.
- PHY 6247 Classical Dynamics-II (3): Hamilton-Jacobi theory, small
  oscillations, continuous systems and theory of classical fields, non-linear
dynamics and recent developments in chaotic dynamics.
- PHY 6346 Electrodynamics-I (3): Electrostatics and magnetostatics,
  boundary-value problems in macroscopic media and dielectrics, electromag-
netic waves and Maxwell’s equations, conservation laws.
- PHY 6347 Electrodynamics-II (3): Propagation of electromagnetic
  waves in wave-guides, resonant cavities and optical fibers, radiating sys-
tems, scattering and diffraction of electromagnetic waves, special relativity,
dynamics of relativistic particles and electromagnetic fields, radiation by
moving charges.
- PHY 6498 Fluid and Plasma Physics I (3): Introduction to modern
  fluid physics including: ideal viscous, and non-equilibrium flow, thermody-
namics and statistical mechanics of equilibrium plasmas, transport phe-
nomena; high temperature hydrodynamics; kinetic equations, non linear
systems; and turbulence.
- PHY 6524 Quantum Statistical Mechanics (3): Canonical structure
  and formulation of statistical mechanics, the thermodynamic limit, gas and
  liquid theory, phase transitions and critical phenomena, virial expansion,
  quantum statistics.
- PHY 6645 Quantum Mechanics-I (3): Quantum theory of measure-
  ment, wave mechanics, Schrodinger theory, semi-classical WKB approxi-
imation, bound state techniques, periodic potentials, angular momentum,
scattering theory; phase shift analysis.
- PHY 6646 Quantum Mechanics-II (3): Spin and other two dimen-
sional systems, matrix mechanics, rotation group, symmetries, time inde-
dependent or time dependent perturbation theory, atomic and molecular sys-
tems, Feynman diagrams, basic scattering theory.
- PHY 6653 Advanced Collision Theory (3): Formal solutions of multi-
channel scattering theory in both time-dependent and time-independent
formalism. Approximations including Born, Semi-classical, variational.
Applications to simple atomic and molecular systems. Role of orientation
and alignment on cross sections and/or for other observables. Numerical tech-
niques, computer programming and implementation.
- PHY 6656 Quantum Theory of Angular Momentum (3): Angular
momentum operators and wave functions, couplings of two angular
momentum, vectors, rotation transformations coupling of more than two
angular momenta, spherical tensor operators, the rigid rotor model.
- PHY 6668 Quantum Field Theory-I (3): Elementary relativistic quanti-
tum field theory: the Klein Gordon field, the Dirac field, interacting fields
and Feynman diagrams, elementary processes of quantum electrodynamics, introduction of radiative corrections, renormalization theory.

PHYS 6669 Quantum Field Theory-II (3): The non-abelian gauge theories: the Parton model of hadron structure, quantization of non-abelian gauge theories, quantum chromodynamics (QCD), gauge theories with spontaneous symmetry breaking, quantization of spontaneously broken gauge theories. Continuation of PHYS 6668.


PHYS 6815 Advanced Graduate Laboratory in Physics (3): Individualized work in experimental physics. There are over thirty experiments which represent early quantum physics, nuclear physics, condensed matter physics, monote carlos and stochastic processes, photonics, renewable energy source, bubble memory, electron spin resonance, atomic spectroscopy. Students are required to complete six experiments during the term.

PHYS 6918B Supervised Research (1-9): Graduate student research supervised by the dissertation advisor. Available to graduate students who have passed the qualifying examination for the physics doctoral program and have not taken the advancement to candidacy examination for the doctorate in physics.

PHYS 6938 Special Topics in Physics (2-4): Special topics is a faculty supervised study of advanced subjects in experimental and/or theoretical physics.

PHYS 6966 Master's Comprehensive Examination (0): (S/U grade): Course to be taken during semester in which the Master's comprehensive examination is to be taken.

PHYS 8976 Master's Thesis Defense (0): Course to be taken during semester in which the Master's thesis defense is to be made.

PHYS 8980 Doctoral Dissertation (1-9): The doctoral dissertation course is designed for physics graduate students who have successfully passed the qualifying and advancement to candidacy examinations; have finished all dissertation research requirements; and are in preparation for the dissertation defense.

PHIZ 6115 Mathematical Methods for Physics-I (3): Analytical function theory, linear vector spaces, tensor calculus, function space, orthogonal polynomials, Fourier analysis and introduction to group theory.


PHIZ 6136 Group Theory in Physics-I (3): Introduction to group theory; generators of continuous groups, orbital angular momentum, angular momentum coupling, homogenous Lorentz and inhomogeneous Poincare groups, symmetries and invariance principles.

PHIZ 6137 Group Theory in Physics-II (3): Born-Oppenheimer approximation, rotational and vibrational molecular wave functions, multi-electron wave functions and operators, Hartree-Fock approximations, configuration interaction, pair and coupled pair theories, many-body perturbation theory.

PHIZ 6156 Advanced Computer Methods in Physics (3): Introduction to computer operating systems and compilers, scientific programming, vector and parallel processing solutions to linear algebraic equations, Fourier transforms and spectral methods, boundary value problems, partial differential equations and graphical methods.

PHIZ 6236 Theory of Atomic and Molecular Collisions (3): Classical and quantum scattering by central forces, phase shifts analysis and cross sections, elastic and inelastic scattering, multi-channel scattering theory, Schwinger, Kohn, and Newton methods, scattering in the laboratory and center of mass reference frames, fundamentals of experimental techniques, and selected topics from different collision theories: electron-atom, electron-molecule, atom-atom, atom-ion, and atom-molecule.

PHIZ 6304 Nuclear Physics (3): Nuclear symmetries and conservation laws, the force between nucleons, nuclear structure, nuclear models.

PHIZ 6426 Condensed Matter Physics-I (3): Application of group theory to crystal structures, band structure of metals and semiconductors. The tight-binding method and applications to insulator bands and impurity states. Thermodynamics, transport and optical properties of metals and semiconductors.


PHIZ 6607 General Relativity (3): The Einstein field equations are developed via a tensor and geometric approach and used to describe astronomical systems and cases of matter under extreme conditions.

PHIZ 6651 Quantum Scattering Theory (3): Time-dependent, formal scattering theory, time-independent formal scattering theory, physical cross sections, methods and approximations for formal solutions, single-channel scattering in three dimensions, complex angular momentum (Watson-Regge method), multi-channel theory, decay of unstable states.

PHIZ 6656 Quantum Theory of Angular Momentum (3): Angular momentum operators and wave functions, coupling of two angular momentum vectors, rotation transformations, coupling of more than two angular momenta, spherical tensor operators, the rigid rotor model.

PHIZ 6676 Particle Physics (3): Leptons, mesons, and baryons, introduction to the Standard Model of Electroweak Interactions and its applications, Higgs mechanism, construction of the standard model, phenomenology of weak interactions, QCD and scaling violation.

Physics Graduate Faculty By Rank

Professor Emeritus: Greenfield, Mark B.

Professors: Etemadi, Babak; Ignatuz, Milton G.; Jain, Babu, L.; Johnson, II, Joseph A.; Kennedy, Robin J.; Sahai, Bidhan, C.; Treadwell, Elliott; Tucker, William P.; Weatherford, Charles A.; Williams, Ronald L.

Associate Professors: Apparat, Richard; Belay, Kayaluy; Encinosa, Mario R.; Johnson, Lewis, E.; Mochena, Mogus; Niculescu, Halima; O'Neal, Ray; Stampe, Patricia A.

Assistant Professors: Jack, Mark A.

Graduate Programs in Psychology

The graduate programs in psychology stress a training objective which places academic emphasis on trainees acquiring appropriate multicultural psychological skills designed to prepare them for professional employment or doctoral level training. Within this context, the programs incorporate an emphasis on Black psychology and minority mental health. Thus, the program is structured so as to incorporate within the framework of training, i.e., content courses as well as experiential exposure, a multicultural orientation to psychology.

Eligibility for admission to the graduate programs in psychology is based on the admission standards of the State University System. This consists of a minimum GPA of 3.00 (on a 4.00 system) over the last 60 semester hours of undergraduate study, or a minimum combined score of 1,000 on the aptitude sections of the Graduate Records Examination. Along with the application, official transcripts and standardize test scores, applicants must have three letters of recommendation submitted on their behalf. The psychology department's admission committee reviews and evaluates all applications in terms of their satisfying the admissions criteria. All applications meeting the criteria are recommended for admission to the department chairperson and letters of acceptance are sent out a short time thereafter.

The curriculum is composed of a community psychology track and a school psychology track. Some of the courses overlap between the two tracks, while other courses are unique to the State certification requirements for school psychologists. Elective courses beyond the two required tracks are also available and further enhance the breadth and quality of the training curriculum.

Community Psychology

Master of Science

The graduate programs in community psychology provide students with academic, research and multicultural skills designed to prepare them for professional employment or doctoral level training. Within this context, the program incorporates an emphasis on Black psychology and mental