Physics and Astronomy

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Physics and Astronomy Web Site (http://www.tamuc.edu/physics/)

The Department of Physics and Astronomy provides coursework, training, and research experience to students who wish to further their education beyond the bachelor's level to achieve a greater degree of competence and recognition in their profession. The department offers an MS in Physics, with thesis and non-thesis options and a MA in Physics with an Emphasis in Physics Teaching.. The thesis option is taken by traditional MS students who may be interested in going on to a Ph.D program. The non-thesis option includes an Applied Physics emphasis for those planning on working in industry, while the MA with an Emphasis in Physics Teaching is offered completely online. The Physics Teaching Emphasis is designed to support high school physics teachers by reinforcing physics content knowledge introducing modern topics in physics and astronomy and providing inspiration for transferring modern topics into the high school classroom.

The Physics and Astronomy Department provides well-equipped instructional and research laboratories. Sophisticated equipment and faculty direction are available for experimental research in organic semiconductor physics, solid state physics, X-ray spectroscopy, and surface physics.

Faculty also conduct research in theoretical nuclear physics, nuclear astrophysics, observational and computational stellar astrophysics, computational physics and physics education research. In addition, the department has an active astronomy and planetary science research program in collaboration with staff members of the planetarium. The department is a member of the Southeastern Association for Research in Astronomy (SARA), which provides remote access for students and faculty to three 1-m class telescopes at these premiere observing sites, Kitt Peak National Observatory (KPNO) in Arizona, USA, Cerro Tololo International Observatory (CTIO) in Chile, and Roque de los Muchachos Observatory (ORM) in the Canary Islands. The department also operates an observatory located 5 miles south of campus that provides hands-on and remote access to a 0.7-m telescope - the largest in northeast Texas.

Programs of Graduate Work

Master of Science in Physics - Thesis

The Master of Science in Physics with research thesis is ordinarily chosen by those students preparing for further graduate study leading to the PhD degree, industrial employment, or for college teaching. The Physics MS - Thesis degree program requires the completion of a research thesis and 30 semester hours, including 2 courses (6 semester hours) allotted to the thesis.

Master of Science in Physics - Non-Thesis w/Applied Physics Emphasis

The applied physics emphasis is designed for students who plan to have a career in a technical industry with a scientific, engineering or programming emphasis. The coursework in this emphasis beyond the required core courses focuses on the practical hands-on aspects of physics. Applied physics differs from engineering in that the applied physicist might not be designing a specific item, but might instead be using physics to help develop new technologies or to assist in solving an engineering problem. An applied physicist is a *generalist* who can be called upon to contribute in several different arenas in a technology company. The Physics MS - Non Thesis degree program requires 36 semesters hours of courses.

Master of Arts in Physics - Non-Thesis w/Teaching Emphasis

This fully online emphasis is designed for high-school physics teachers who may not necessarily have a degree in physics or for those that may have been working in the industry but have decided to try teaching as a profession. It is based around 6 courses which introduce students to advanced physics content such as quantum physics and astrophysics. As well as the physics itself, students will examine the historical context of the subjects, and their pedagogy with an aim to introducing modern physics content into the high school classroom. This Master's program will reinforce teacher's physics content knowledge and allow teachers to instruct dual enrollment courses and at the community college level.

The suggested minimum undergraduate courses include a year of calculus-based physics, modern physics, and mathematics up through differential equations; those students who do not have this minimum will be expected to take the "Mathematical Methods for Educators" course during their first semester. The Physics MA - Option II Non Thesis degree program requires 36 semester hours.

Admission

Admission to a graduate program is granted by the Dean of the Graduate School upon the recommendation of the department. Applicants must meet the following requirements for admission in addition to meeting the general university requirements in Physics.

- Admission Requirements (https://www.tamuc.edu/programs/physics-ms/#Admission)

Departmental Requirements

Physics graduate students in the Thesis program and the Non Thesis Applied Physics Emphasis must register for PHYS 501 Graduate Seminar each semester in residence. A comprehensive examination is required of all students majoring in physics.

Successful completion of the Comprehensive Exam is required of all students.

Note: Individual departments may reserve the right to dismiss from their programs students who, in their judgment, would not meet the professional expectations of the field for which they are training.

Physics MA (https://coursecatalog.tamuc.edu/grad/colleges-and-departments/science-engineering/physics-astronomy/physics-with-emphasis-in-physics-teaching-ma/)

Physics MS (https://coursecatalog.tamuc.edu/grad/colleges-and-departments/science-engineering/physics-astronomy/physics-ms/)

Physics Minor (https://coursecatalog.tamuc.edu/grad/colleges-and-departments/science-engineering/physics-astronomy/physics-minor/)

ASTR 503 - Galactic Astronomy
Hours: 3
This course covers numerous topics related to the structure and evolution of galaxies. Modern astrophysical observational techniques, stellar properties, and dust extinction are introduced in a galactic astronomy context. The physical structure and evolution of star clusters and galaxies, components of the Milky Way, and properties of the interstellar medium are also discussed. Finally, students analyze theories and observations of stellar dynamics and the cosmological distance scale.

ASTR 589 - Independent Study
Hours: 1-4
Independent Study 1-4 semester hours.

ASTR 597 - Special Topics
Hours: 1-4
Special Topics. One to Four semester hours. Organized class. May be repeated when topics vary. Some sections are graded on a Satisfactory (S) or Unsatisfactory (U) basis.

PHYS 501 - Graduate Seminar
Hours: 1
This course may be taken each of four semesters for credit.

PHYS 511 - Advanced Classical Mechanics
Hours: 3
An advanced course in classical mechanics including the methods of Lagrange, Hamilton, matrices, tensors, and Hamilton-Jacobi theory.

PHYS 512 - Classical Electromagnetic Theory
Hours: 3
Electrostatics, magneto-statics, multiple expansions, solution of boundary value problems, slowly varying currents, electromagnetic energy and momentum, Maxwell's equations and applications.

PHYS 513 - Computational Physics
Hours: 3
Numerical experimentation has supplemented laboratory experimentation and theory as a viable approach to studying the laws of nature. Students will learn techniques and traps of programming, and then learn to write computer code to solve applications including: finite difference methods; realistic classical mechanics problems including friction or N mutually-interacting bodies; Laplace's equation in electrostatics; wave motion; random processes including diffusion, cluster growth models, and the Monte Carlo method; Fourier transforms and Fourier filtering.

PHYS 514 - Statistical Physics
Hours: 3
General principles of statistical thermodynamics, equilibrium statistics of special systems, kinetic theory, diffusion and transport phenomena, and classical and quantum statistical mechanics.

PHYS 515 - General Relativity
Hours: 3
Einstein’s principle of equivalence between physics in accelerating frames of reference and in local gravitational fields is the starting point; we demonstrate the relationship between the problem of getting rid of fictitious forces in accelerating frames by coordinate transformations and doing the same for gravitational forces. We then develop basic tensor algebra and calculus within the framework of special relativity, before introducing general coordinate transformations, the curvature tensor and the Einstein field equations. Tests and applications of the theory will include the effect on the GPS, the precession of the perihelion of Mercury, gravitational lensing, gravitational waves, black holes and neutron stars, and the Friedmann equations describing the expansion of the universe.

PHYS 517 - Mathematical Methods in Physics
Hours: 3
Covers mathematical methods used in classical and modern physics and in the engineering sciences. Topics include vectors and curvilinear coordinates, matrices and linear algebra, operators and eigenvalues, boundary value problems, Fourier and Laplace transforms, partial differential equations of physics, Green's functions, and variational methods. Emphasis is placed on problem solving.

PHYS 518 - Thesis
Hours: 3,6
Research leading to the master's thesis. Three or six semester hours.

PHYS 520 - Quantum Mechanics
Hours: 3
Schroedinger equation, discrete and continuous eigenfunctions and eigenvalues, collision theory, matrix mechanics, angular momentum perturbation and other approximation methods, identical particles and spin, theory of radiation, and atomic structure.

PHYS 521 - Solid State Physics
Hours: 3
Includes a study of crystal structure, crystal diffraction and the reciprocal lattice, crystal binding, lattice vibrations, phonons, Brillouin zones, energy bands in metals and Fermi surfaces.

PHYS 523 - Advanced Atomic, Molecular, and Materials Physics
Hours: 3
A study of theoretical and applied aspects of atomic, molecular, and solid structure. Topics include atomic and molecular models of materials, ionization phenomena, X-ray, X-ray diffraction, and atomic collisions. Experimental investigations of atomic phenomena will be stressed. Prerequisites: PHYS 520 or equivalent or consent of instructor.

PHYS 524 - Surface Physics
Hours: 3
Theory, principles and applications of surface characterization techniques to modern technological problems. Topics covered include ultra-high vacuum techniques, X-ray, ion and electron spectroscopes. Prerequisites: Consent of instructor.

PHYS 526 - Quantum Mechanics: Analysis and Applications
Hours: 3
The history of quantum mechanics including the experimental results that required a new theory of the interaction between light and matter at microscopic level. The uncertainty principle, wave-particle duality and wave mechanics. Applications (including simple calculations) to atomic physics, nuclear physics, semiconductors, lasers; how quantum mechanics has shaped the modern world. The impact of quantum mechanics in our culture; its uses and misuses. Prerequisites: University physics and calculus up to partial differential equations.

PHYS 530 - Mathematical Methods: Analysis and Applications
Hours: 3
Vectors and curvelinear coordinates, partial differential equations, linear and non-linear systems, matrix algebra, boundary value problems, Fourier transforms, separation of variables, Sturm-Lioville eigenfunction expansion theory, numerical techniques.

PHYS 531 - Classical Mechanics: Analysis and Applications
Hours: 3
Basic topics in motion, forces, properties of matter, energy, and related topics will be explored in the framework of Hamiltonian and Langragian mechanics. The elegant derivation of basic conservation laws will be demonstrated using Noether’s theorem. Modern topics such as Chaotic systems and special relativity will be introduced. Emphasis will be placed on conceptual understanding. Prerequisites: University physics and calculus up to partial differential equations.

PHYS 531A - Classical Mechanics: Analysis and Applications
Hours: 3
(Same as PHYS 531) Basic topics in motion, forces, properties of matter, energy, and related topics will be explored in the framework of Hamiltonian and Langragian mechanics. The elegant derivation of basic conservation laws will be demonstrated using Noether's theorem. Modern topics such as Chaotic systems and special relativity will be introduced. Emphasis will be placed on conceptual understanding. Prerequisites: University physics and calculus up to partial differential equations.

PHYS 532 - Electromagnetism: Analysis and Applications
Hours: 3
Topics include vector analysis, electrostatics, magnetostatics, Maxwell's Equations, and electrodynamics. Connections to modern applications will be explored. Emphasis will be placed on conceptual understanding. Prerequisites: University physics and calculus up to partial differential equations.

PHYS 532A - Electromagnetism: Analysis and Applications
Hours: 3
(Same as PHYS 532) Topics include vector analysis, electrostatics, magnetostatics, Maxwell's Equations, and electrodynamics. Connections to modern applications will be explored. Emphasis will be placed on conceptual understanding. Prerequisites: University physics and calculus up to partial differential equations.

PHYS 535 - Thermodynamics: Analysis and Applications
Hours: 3
The principles and applications of statistical thermodynamics, thermal and general interactions of macroscopic systems and parameter measurement. Also includes the basic description of statistical mechanics and kinetic theory. Emphasis will be placed on conceptual understanding.

PHYS 536 - Computational Physics: Analysis and Applications
Hours: 3
Computational methods will be introduced including basics of Python programming language, using numerical methods to take derivatives and evaluate integrals, solving differential equations, and plotting. Spreadsheets will be explored as an alternative method to solving differential equations. Coding techniques will be applied in the context of waves including harmonic oscillatory systems, wave interference, traveling waves, and diffraction. Modern topics such as chaotic systems will be introduced. Emphasis will be placed on programming and conceptual understanding. No previous coding experience is required.

PHYS 541 - Nuclear Physics
Hours: 3
The study of nuclear phenomena as well as properties of nuclei including mass, stability, magnetic moment, radioactive decay processes and nuclear reactions. The application of nuclear physics principles to other fields such as astronomy, engineering, manufacturing, and medicine.

PHYS 542 - Advanced Instrumentation and Control
Hours: 3
Instrumentation and control principles for real-time systems. Topics include physics of sensors and actuators, sensor signal conditioning, real-time data acquisition, signal processing, motion control, and software for modern instrumentation.

PHYS 550 - Nuclear Astrophysics
Hours: 3
Nuclear astrophysics describes the elemental and energy production in stars via nuclear reactions. It explains the occurrence of all the naturally occurring chemical elements in the universe from the simplest elements to the most complex. It also explains how astrophysical neutrinos (from the sun, cosmic rays and supernovae) are produced and detected and what they have to say about both neutrinos and the universe. Nuclear astrophysics also describes how the structure of compact stars (e.g. neutron stars) arises due to the interactions of protons, neutrons, electrons, and quarks and gluons. The course will also explain how the Universe evolved from a primordial state to the present epoch. Prerequisites: PHYS 517 or consent of instructor.

PHYS 552 - Advanced Micro-Controller Electronics
Hours: 3
Embedded logic design and programming. Topics include micro-controller selection, peripheral interfacing, low and high-level programming languages, and microcontroller development tools. Prerequisites: Consent of the instructor.

PHYS 561 - Astronomy & Astrophysics: Analysis and Applications
Hours: 3
Topics in solar system dynamics, stellar structure and evolution, galactic evolution and dynamics and cosmology will be studied, making use of projects based on citizen science initiatives such as the Zooniverse that open up astronomical research participation to the public. Prerequisites: University physics and calculus up to partial differential equations.

PHYS 572 - Parallel Computing
Hours: 3
Parallel Computing. Three semester hours. (Same as CSci 572) Computer topologies and networks, programming techniques, and parallel algorithms for multiprocessor and multi-computer systems including microcomputer clusters. Prerequisites: Physics 319 or CSci 322. Cross-listed with CSci 572.

PHYS 589 - Independent Study
Hours: 1-4
Independent Study. One to four semester hours. Individualized instruction/research at an advanced level in a specialized content area under the direction of a faculty member. May be repeated when the topic varies. Prerequisite: Consent of department head.

PHYS 595 - Research Literature and Techniques
Hours: 3
Research Literature and Techniques. Three semester hours. A course designed to acquaint the student with the role of research in the initiation, development, and modification of concepts and theories in physics. Articles in professional journals in the field will be assigned for review, especially in areas in which theories are in a state of flux. The student will be encouraged to devise experiments through which clarification of concepts may result.

PHYS 597 - Special Topics
Hours: 1-4
Special Topics. One to Four semester hours. Organized class. May be repeated when topics vary. Some sections are graded on a Satisfactory (S) or Unsatisfactory (U) basis.