Physics (B.A., B.S.)

The science of physics seeks understanding of the behavior of matter and energy at the most general and fundamental level. The physicist is trained to explore the physical universe in which people live and seeks interpretations of the natural phenomena found there. While much is known about the physical universe, many phenomena still remain to be investigated, understood, and exploited to the ultimate benefit of humankind. This is the challenge that a modern physicist faces.

The Degrees

The student majoring in Physics must meet the general university requirements for admission and for the specific degree the student is seeking. The Physics Program offers both the Bachelor of Arts and the Bachelor of Science degrees.

Bachelor of Arts

The Bachelor of Arts program provides an opportunity for a strong base in physics for students wishing to pursue graduate studies (nonphysics) in, for example, medicine, business administration, biophysics, oceanography, and patent or high technology law. Additionally, students seeking certification as high school teachers with physics as a major specialization and those seeking employment in industry, government service, and computer technology have the opportunity to obtain the necessary physics background through this program. The lower-division course requirements for the B.A. degree are the same as those for the B.S. degree. At the upper-division level, 26 hours of physics and 15 hours of science electives are required, making a total of 122 credit hours.

Bachelor of Science

The Bachelor of Science is intended for students interested in a professional career in physics or immediately adjacent fields. Fifty-six hours of physics, eight hours of chemistry and 16 hours of mathematics are included in the 126 credit hours required for the degree.

Graduate Studies Track

The recommended course of study toward a Bachelor of Science degree for those students who intend to pursue graduate studies in Physics begins with a two-semester Honors sequence of fundamentals of physics that gives the student a more extensive foundation in basic physics. The remainder of the program is the same as the regular B.S. program. A total of 126 credit hours is required.

Algebra Based Physics

An algebra based general physics course (PHYS 1301, 1302) with lab (PHYS 1101, 1102) is offered for students interested in the health sciences and those curious about the physical world in which we live. It stresses understanding the workings of nature and the physical processes and phenomena occurring therein.

Minor in Physics (20 hours)

A minor is offered that consists of PHYS 2325/2125 and 2326/2126, 3311, 3352 and two other upper-division physics courses.
Fast Track Baccalaureate/Master's Degrees

For students interested in pursuing graduate studies in physics, the Physics Department offers an accelerated B.S./M.S. Fast Track that involves taking graduate courses in lieu of several advanced undergraduate courses. Acceptance into the Fast Track is based on the student's attaining a GPA of at least 3.0 on a minimum of 30 hours of upper-division courses that include PHYS 3311, 3312, 3416, 3330 and 3352. Such students may take up to 15 credit hours of selected graduate courses that may be used to complete the bachelor's degree and also satisfy requirements for the master's degree. These credits will partially satisfy the M.S. degree requirements when the student completes the B.S. degree. Interested students should contact their advisor during their junior year to apply to the Fast Track program.

Bachelor of Science in Physics Degree Requirements (126 hours)

I. Core Curriculum Requirements: 42 hours

- A. Communication (6 hours)
  - 3 hours Communication (RHET 1302)
  - 3 hours Communication Elective
- B. Social and Behavioral Sciences (15 hours)
  - 6 hours Government (GOVT 2305 and 2306)
  - 6 hours History (HST 1301 and 2301)
  - 3 hours Social and Behavioral Sciences Elective
- C. Humanities and Fine Arts (6 hours)
  - 3 hours Fine Arts (AP 1301)
  - 3 hours Humanities (A&H 1301)
- D. Mathematics and Quantitative Reasoning (6 hours)
  - 6 hours Calculus (MATH 2417 and 2419)
- E. Science (9 hours)
  - 8 hours Chemistry (CHM 1311, 1111, 1312, 1112)
  - 1 hour Physics (PHY 1100)

1 Curriculum Requirements can be fulfilled by other approved courses from accredited institutions of higher education. The courses listed in parenthesis are recommended as the most efficient way to satisfy both Core Curriculum and Major Requirements at U.T. Dallas.

II. Major Requirements: 66 hours

- Major Preparatory Courses (21 hours)
  - MATH 2417 Calculus I
  - MATH 2419 Calculus II
  - MATH 2421 Multivariable Calculus*
  - MATH 2420 Differential Equations*
  - PHYS 2325/2125 Mechanics and Heat with recitation/Lab*
  - PHYS 2326/2126 Electromagnetism and Waves with recitation/Lab*
  - PHYS 2303 Contemporary Physics*
  - PHYS 2321/2125 Honors Physics I with recitation/Lab
  - PHYS 2322/2126 Honors Physics II with recitation/Lab
- Major Core Courses (26 hours)
  - PHYS 3311 Theoretical Physics I
  - PHYS 3312 Theoretical Physics II
  - PHYS 3330 Numerical Methods

3 Curriculum Requirements can be fulfilled by other approved courses from accredited institutions of higher education. The courses listed in parenthesis are recommended as the most efficient way to satisfy both Core Curriculum and Major Requirements at U.T. Dallas.
PHYS 3352 Modern Physics I  
PHYS 3416 Electricity and Magnetism  
PHYS 3425 Electronics  
PHYS 4311 Thermodynamics and Statistical Mechanics  
PHYS 4373 Physical Measurements Lab

Major Related Courses (19 hours)  
PHYS 4112 Advanced Physics Lab  
PHYS 4301 Quantum Mechanics I  
PHYS 4328 Optics  
PHYS 4352 Modern Physics II  
9 hours Physics Electives

Advanced Writing  
PHYS 4399 Thesis  
or NATS 4310 Advanced Writing in the Natural Sciences and Mathematics  
or Summer Research Project or COOP program with written final report

2 Two hours of Calculus are counted as Major Preparatory credit; six hours are counted in Core Curriculum.  
3 Required preparatory coursework.  
4 Honors Physics sequence may be substituted for PHYS 2325/2125 and PHYS 2326/2126 for eligible students.  
* Indicates a prerequisite class to be completed before enrolling for upper-division classes.

III. Elective Requirements: 18 hours

Advanced Electives (6 hours)  
All students are required to take at least six hours of advanced electives outside their major field of study. These must be either upper-division classes or lower-division classes that have prerequisites.

Free Electives (12 hours)  
Both lower- and upper-division courses may count as electives, but the student must complete at least 51 hours of upper-division credit to qualify for graduation.

Physics Electives  
PHYS 3380 Astronomy  
PHYS 4318 Particle Physics  
PHYS 4371 Solid State Physics  
PHYS 4372 Solid State Devices  
PHYS 4381 Space Physics  
PHYS 4383 Plasma Physics  
PHYS 4385 The Sun, the Atmosphere, and Global Change

Other Courses  
PHYS 1301/1101 College Physics I with Lab  
PHYS 1302/1102 College Physics II with Lab  
PHYS 3341 Physics for Bio Science I  
PHYS 3342 Physics for Bio Science II

Specified Course Descriptions

A&H 1301 (HUMA 1301) Exploration of the Humanities (3 semester hours) An introduction to the concept of cultural tradition through the study of selected works of literature, philosophy, music, and visual art. Emphasis on the relations among various forms of cultural expression and developing students' ability to interpret complex artistic works in their historical, cultural, and intellectual contexts. General education core course. (3-0) S
AP 1301 (ARTS 1301) Exploration of the Arts (3 semester hours) This course introduces students to the physical and intellectual demands required of the author, the performer, and the visual artist. This introduction includes, but is not limited to, the student's production of a creative project as well as written assessments of art and performance. (3-0) Y

CHM 1111 (CHEM 1111) General Chemistry Laboratory I (1 semester hour) Introduction to the chemistry laboratory. Experiments are designed to demonstrate concepts covered in CHM 1311; including properties and reactions of inorganic substances, and elementary qualitative and quantitative analysis. (0-3) S

CHM 1112 General Chemistry Laboratory II (1 semester hour) A continuation of CHM 1111 demonstrating the concepts covered in CHM 1312, including acid-base chemistry, reaction kinetics, electrochemistry, polymers, and organic synthesis. Prerequisite: CHM 1111 or 1215. (0-3) S

CHM 1311 (CHEM 1311) General Chemistry I (3 semester hours) Introduction to elementary concepts of chemistry theory. The course emphasizes chemical reactions, the mole concept and its applications, and molecular structure and bonding. (3-0) S

CHM 1312 (CHEM 1312) General Chemistry II (3 semester hours) A continuation of CHM 1311 treating metals; solids, liquids, and intermolecular forces; chemical equilibrium; electrochemistry; organic chemistry; rates of reactions; and environmental, polymer, nuclear, and biochemistry. Prerequisite: CHM 1311 or 1315. (3-0) S

GOVT 2305 (GOVT 2305) Constitutional Foundations and Political Behavior in the U.S. and Texas (3 semester hours) This course examines the evolution and current state of political behavior and public policy making in the U.S. and Texas. Topics discussed will include the constitutions, federalism, intergovernmental relations, voting, elections, political parties, public opinion, and interest groups. (Fulfills one-half of the legislative requirement of 6 hours of American government.) (3-0) S

GOVT 2306 (GOVT 2306) Political Institutions in the U.S. and Texas (3 semester hours) This course explores the primary institutions of U.S. and Texas government. It examines the bureaucracy as well as the executive, legislative, and judicial branches of government at the state and federal level. (Fulfills one-half of the legislative requirement of 6 hours of American government.) (3-0) S

HST 1301 Themes and Ideas in American History (3 semester hours) An introduction to the methods of historical inquiry through the study of selected main themes in American history. A course designed to offer students an understanding of the historical and cultural context of America in the contemporary world. Fulfills one-half of the Texas legislative requirement for six hours in American history. (3-0) S

HST 2301 Issues in American History (3 semester hours) Readings, commentary, and discussion aimed at varying aspects of history and culture. Fulfills one-half of the Texas legislative requirement for six hours in American history. (3-0) Y

MATH 2417 (MATH 2417) Calculus I (4 semester hours) Functions, limits, continuity, differentiation; integration of function of one variable; logarithmic, exponential, and inverse trigonometric functions; techniques of integration, and applications. Three lecture hours and two discussion hours a week. Prerequisite: MATH 2312 or equivalent. (4-0) S

MATH 2419 Calculus II (MATH 2419) (4 semester hours) Continuation of MATH 2417. Improper integrals, sequences, infinite series, power series, parametric equations and polar coordinates, vectors, vector-valued functions, functions of several variables, partial derivatives and applications, multiple integration. Three lecture hours and two discussion hours a week. Prerequisite: MATH 2417. (4-0) S

MATH 2420 (MATH 2420) Differential Equations with Applications (4 semester hours) Topics covered will be drawn from the following list: First order differential equations, ordinary differential equations, system of linear differential equations, stability, series solutions, special functions, Sturm-Liouville problem, Laplace transforms and linear differential equations, numerical solutions and applications in physical sciences and engineering using computers. Three lecture hours and two discussion hours per week. Prerequisite: MATH 2419. (4-0) S

MATH 2421 Multivariable Calculus with Applications (4 semester hours) Vectors, matrices, vector functions, partial derivatives, divergence, curl, Laplacian, multiple integrals, line and surface integrals, Green's, Stoke's, and Gauss's theorems, and applications in physical sciences and engineering. Three lecture hours and two discussion hours per week. Prerequisite: MATH 2419. (4-0) S

NATS 4310 Advanced Writing in the Natural Sciences and Mathematics (3 semester hours) A writing-intensive course on questions or problems in natural sciences and mathematics; satisfies the advanced writing requirement for graduation. (3-0) S
PHYS 1100 The Fun of Physics (1 semester hour) An introductory course in physics in the modern world. Focuses on the work of a physicist. What does a physicist do? What are some of the exciting topics on which physicists are working today? The faculty discuss their favorite concepts and the opportunities for student participation in research. Must be taken on a Credit/No Credit basis only. (1-0) Y

PHYS 1101 (PHYS 1101) College Physics Laboratory (1 semester hour) A laboratory to accompany PHYS 1301. Corequisite: PHYS 1301 (0-3) Y

PHYS 1102 (PHYS 1102) College Physics Laboratory II (1 semester hour) A laboratory to accompany PHYS 1302. Corequisite: PHYS 1302. (0-3) Y

PHYS 1301 (PHYS 1301) College Physics I (3 semester hours) Algebra based basic physics. Topics include mechanics, heat and thermodynamics. Prerequisite: MATH 1314. (3-0) Y

PHYS 1302 (PHYS 1302) College Physics II (3 semester hours) Continuation of PHYS 1301. Topics include electricity and magnetism and optics. Prerequisites: PHYS 1301. (3-0) Y

PHYS 2125 (PHYS 2125) Physics Laboratory I (1 semester hour) Laboratory course to accompany PHYS 2325. Personal computer-based data presentation and curve fitting. Basic measurement concepts such as experimental uncertainty, mean, standard deviation, standard error, and error propagation will be covered. Corequisite: PHYS 2325. (0-3) Y

PHYS 2126 (PHYS 2126) Physics Laboratory II (1 semester hour) Laboratory course to accompany PHYS 2326. Builds on concepts of Physics Lab I. Will emphasize the use of an oscilloscope and measurements using simple circuits constructed in class. Corequisite: PHYS 2326. (0-3) Y

PHYS 2303 Contemporary Physics (3 semester hours) Topics include the fundamentals of geometric optics, basic relativity and preliminary quantum concepts. (3-0) Y

PHYS 2321 Honors Physics I - Mechanics and Heat (3 semester hours) Calculus-based basic physics. This class is a more rigorous version of PHYS 2325. Heavier emphasis on derivations, more challenging problems and applications. Prerequisite: MATH 2417. Corequisite: PHYS 2125 (3-0) Y

PHYS 2322 Honors Physics II - Electricity and Magnetism (3 semester hours) Second course in this sequence. This course is a more rigorous version of PHYS 2326. Heavier emphasis on derivations, more challenging problems and applications. Prerequisite: PHYS 2321, MATH 2419. Corequisite: PHYS 2126. (3-0) Y

PHYS 2325 (PHYS 2325) Mechanics and Heat (3 semester hours) Calculus based. Basic physics including a study of space and time, kinematics, forces, energy and momentum, conservation laws, rotational motion, torques, harmonic oscillation, temperature and heat. Two lectures and one recitation session per week. Prerequisite: MATH 2417. Corequisite: PHYS 2125. (3-0) Y

PHYS 2326 (PHYS 2326) Electromagnetism and Waves (3 semester hours) Continuation of PHYS 2325. Topics include electrostatics and electromagnetics, electric field and potential, electric currents, magnetic fields, laws of Coulomb, Ampere, and Faraday, Maxwell's theory of propagation and optics. Two lectures and one recitation session per week. Prerequisites: PHYS 2325 and MATH 2419. Corequisite: PHYS 2126. (3-0) Y

PHYS 3311 Theoretical Physics I (3 semester hours) Vector spaces, linear operators, and eigenvectors; ordinary differential equations and eigenfunctions; complex functions and contour integration; Fourier series; integral transforms. Prerequisite: Ordinary Differential Equations (MATH 2420 or equivalent) and PHYS 2303 (3-0) Y

PHYS 3312 Theoretical Physics II (3 semester hours) Newton's laws and conservation of momentum; collisions; two body problems and trajectories; rotating coordinate systems; Lagrangian formulation; rotational dynamics and the inertia tensor; gravitation. Prerequisite: PHYS 3311 or equivalent. (3-0) Y

PHYS 3330 Numerical Methods in Physics (3 semester hours) Numerical Methods - The course covers numerical approaches to solving physics problems. Topics include probability, statistics, data analysis, fits, numerical solutions, Monte Carlo simulations and interpretation of the experimental data. (3-0) Y

PHYS 3341 Physics for Bio Science I (3 semester hours) Calculus based. Basic physics for pre-health science students. Topics include space and time, kinematics, forces, energy and momentum, conservation laws, rotation, thermodynamics, and kinetic theory. Focus is on biological applications. Prerequisite: MATH 2417. Must register for Physics Lab I. (PHYS 2125). (3-0) Y

PHYS 3342 Physics for Bio Science II (3 semester hours) Continuation of PHYS 3341. Topics include electrostatics and electromagnetics, electric field and potential, electric currents, magnetic fields, laws of Coulomb, Ampere, and Faraday; Maxwell's theory of propagation, and optics. Focus is on biological applications. Prerequisites: PHYS 3341 and MATH 2419.
Must register for Physics Lab II. (PHYS 2126) (3-0) Y

**PHYS 3352 Modern Physics I** (3 semester hours) Wave-particle duality, atomic structure, one- and three- dimensional elementary quantum mechanics, energy levels of single- and multi-electron atoms. Fine structure splitting and momenta coupling. Prerequisite PHYS 2303; corequisite: PHYS 3311. (3-0) Y

**PHYS 3380 Astronomy** (3 semester hours) An essentially descriptive course outlining the current views of the universe and the sources of data supporting those views. The solar system and its origin, stars, galaxies, pulsars, quasars, black holes, nebulae and the evolution of the universe. Opportunity to use a U.T. Dallas telescope is provided. Prerequisite: PHYS 2326 (3-0) Y

**PHYS 3416 Electricity and Magnetism** (4 semester hours) Coulomb's and Gauss's laws; two-dimensional representations of the electric field on a computer; graphing the electric field; electrostatics; potential theory; field energy; fields of moving charges and electric currents; the magnetic field; electromagnetic induction; Kirchhoff's laws and computer analysis of RLC circuits including resonance; Maxwell's equations; plane waves; guided waves; dielectrics, magnetic media. Prerequisite: PHYS 3311 or equivalent. (3-0) Y

**PHYS 3425 Electronics** (4 semester hours) Direct and alternating current circuits; characteristics of semiconductor devices, typical electronic circuits, power supplies, amplifiers, oscillators; feedback transients and pulse circuits. Laboratory work will be included as part of the course, and students will be required to purchase a breadboard and battery to power simple circuits they design, build, and demonstrate. (4-0) Y

**PHYS 4112 Advanced Physics Laboratory** (1 semester hour) An advanced laboratory containing experiments in optics, electricity and magnetism; computer interfacing with instrumentation; and developing skills in report writing. Prerequisites: PHYS 2325 and PHYS 2326 (0-3) Y

**PHYS 4301 Quantum Mechanics** (3 semester hours) Fundamental concepts: the Stern Gerlach experiment; the Dirac formalism; kets, bras and operators; base kets and matrix representations. Measurements, observables and the uncertainty relations. Position, momentum, and translation. Wave functions in position and momentum space. Time evolution and Schrödinger's equation, Heisenberg picture. Applications include simple harmonic oscillator and the H-atom. Prerequisites: PHYS 3311, PHYS 3312, and PHYS 3352 or equivalent. (3-0) Y

**PHYS 4311 Thermodynamics and Statistical Mechanics** (3 semester hours) Study of the elements of thermodynamics, kinetic theory, and statistical mechanics; the concepts of temperature, entropy, phase transitions, transport phenomena, partial functions, statistical ensembles; the Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein distributions; and the equipartition theorem. Applications considered will include the thermodynamic description of chemical and phase equilibria, magnetism, superconductivity, and superfluidity. Prerequisites: PHYS 2325 and PHYS 2326. (3-0) Y

**PHYS 4318 Particle Physics** (3 semester hours) Introduction to the physics of elementary particles, covering the strong, electromagnetic and weak interactions, and the leptons, quarks and bosons upon which they interact. Topics will include the elementary zoo: mesons and baryons, sometimes broken symmetries and conservation laws, and the accelerators, detectors, and experimental techniques that are used by elementary particle physicists. Prerequisites: PHYS 3416 and PHYS 4301. (3-0) T

**PHYS 4328 Optics** (3 semester hours) Topics include electromagnetic waves and radiation, the interaction of light and matter, geometric optics, polarization, interference, and diffraction. Prerequisite: PHYS 4316. (3-0) Y

**PHYS 4352 Modern Physics II** (3 semester hours) Topics in this advanced continuation of PHYS 3352 include the application of quantum mechanics and statistical physics concepts to an understanding of the operation of laser and solid state devices; to elucidating molecular and solid state structure; to an appreciation of nuclear structure, models and forces; and to explaining low temperature phenomena. Introductory discussion of subnuclear particles, their properties and interactions. Prerequisite: PHYS 3352. (3-0) Y

**PHYS 4371 Solid State Physics** (3 semester hours) The course covers topics in the theory of perfect crystals including crystallography, lattice energy of ionic crystals, elasticity, lattice vibrations, electric and magnetic properties, and the band theory of solids. Prerequisites: PHYS 3352 and 3416. (3-0) Y

**PHYS 4372 Solid State Devices** (3 semester hours) This course is an introduction to the basic concepts of solid state devices. Topics covered include semiconductor homojunctions and heterojunctions, low dimensional physics, hot electron systems, semiconductor lasers, field effect and heterojunction transistors, microwave diodes, and infrared and solar devices. Prerequisite: PHYS 4371 (3-0) T

**PHYS 4373 Physical Measurements Laboratory** (3 semester hours) Thermodynamics and physical properties of matter,
vacuum technology, gas phase kinetics, spectroscopy, basic operations in electronics, literature skills, and use of computers. Prerequisites: PHYS 3352 and 3316. (0-6) Y

PHYS 4381 Space Science (3 semester hours) A survey of the structure and dynamics of the atmospheres of planets, including ionospheres and magnetospheres, as influenced by the sun's radiation and the solar wind. Topics include aurora and airglow, photochemistry and atmospheric electricity. Prerequisite: PHYS 2323, or PHYS 2326, or equivalent. (3-0) T

PHYS 4383 Plasma Physics (3 semester hours) Plasmas are the 4th state of matter, in which some or all of the neutral particles in a gas are ionized. A working knowledge of plasma physics is important in nuclear physics, semiconductor processing, space science, astronomy, and many other areas. This course will examine the fundamental treatment of plasmas as embodied in the fluid equations, magneto-hydrodynamics, and simple kinetic theory. Specific topics include plasma waves and instabilities, diffusion, guiding center motion and drifts, currents in plasmas, and particle collisions. Prerequisites: PHYS 3311, Prerequisite or corequisite: PHYS 3416 (3-0) R

PHYS 4385 The Sun, the Atmosphere, and Global Change (3 semester hours) A survey of how the varying sun and human activities affect the atmosphere. Topics include the sun and solar wind and their effects on ozone production, cosmic ray variations and in producing changes in weather and climate; the human activities that cause destruction of the ozone layer and cause global and regional changes in climate. May be used to satisfy part of the General Education science requirement. (3-0) R

PHYS 4399 Senior Honors in Physics (3 semester hours) For students conducting independent research for honors theses or projects. Must be done under faculty supervision. (3-0) S

RHET 1302 (ENGL 1302) Rhetoric (3 semester hours) The course presents an integrated approach to writing, reading, and critical thinking by developing the grammatical, logical, and rhetorical skills necessary for university writing. All classes work in a computerized learning environment. Students are taught basic computer literacy and submit all work electronically and on paper. (3-0) S