PHYSICS

Department of Physics

Chairperson: Lorin S. Matthews
Graduate Program Director: David J. Hilton

The department offers the Master of Arts, Master of Science, and Doctor of Philosophy degrees in physics. For admission to major graduate study in physics, students must satisfy the following requirements:

1. Thirty-two semester hours of undergraduate physics, including six semester hours of 4000-level courses in physics.
2. Eighteen semester hours in undergraduate mathematics, including differential equations.

The Graduate Record Examination Subject Test in physics is optional. For admission to minor graduate study in physics, students must have completed a minimum of nineteen semester hours in undergraduate physics and must satisfy the prerequisites for the courses which are to be counted for graduate credit.

- Physics, M.A. and M.S. (https://catalog.baylor.edu/graduate-school/curriculum-departments-institutes-instruction/college-arts-sciences/physics/physics-ma-ms/)
- Physics, Ph.D. (https://catalog.baylor.edu/graduate-school/curriculum-departments-institutes-instruction/college-arts-sciences/physics/physics-phd/)

Physics (PHY)

PHY 4322 Advanced Topics in Classical Physics (3)
Pre-requisite(s): PHY 3320, 3330, and MTH 3326
Continuation of PHY 3320 and 3330. Topics normally include: dynamics of systems of particles: rigid-body motion; coupled oscillations; the wave equation in one dimension; gauge transformations; electromagnetic waves in conductors and nonconductors; dispersion; multiple radiation; Linard-Wiechert potentials; relativistic electrodynamics.

PHY 4340 Statistical and Thermal Physics (3)
Pre-requisite(s): PHY 3372 and MTH 3326
Topics normally include: basic probability concepts; macroscopic thermodynamics; statistical thermodynamics; kinetic theory; quantum statistics.

PHY 4350 Introduction to Stellar Structure and Evolution (3)
Pre-requisite(s): PHY 2455; and MTH 3326 or concurrent enrollment
A quantitative study of the physics of stars and stellar systems. Topics include observed properties of stars and the physics underlying those properties, radiation and stellar spectra, the interior structure of stars, the life cycles of stars, white dwarfs, neutron stars, and black holes.

PHY 4351 Introduction to Modern Cosmology (3)
Pre-requisite(s): PHY 4350 and MTH 3326
An introduction to modern cosmology, including observational cosmology, Newtonian gravity, relativistic cosmological models, thermal history of the universe, dark matter and dark energy, inflationary models, the origin of the light elements, structures in the universe, and the cosmic microwave background radiation. The principles of Einstein's general theory of relativity and observations in experiments will also be covered.

PHY 4360 Computer Models in Physics (3)
Pre-requisite(s): PHY 3320, 3372, and CSI 3324
Application of contemporary computer methods to the solution of physics and engineering problems. Theory and applications of finite difference equations. Deterministic, discrete, and continuous models. Computer graphics. Waves in classical and quantum physics. Monte Carlo calculations, electric circuits, partial differential equations in physics and engineering.

PHY 4372 Introductory Solid State Physics (3)
Pre-requisite(s): PHY 3373
Topics normally include: crystal structure; reciprocal space; elastic and thermal properties; electronic structure; the Fermi surface; elementary semiconductor physics; dielectric and magnetic properties of solids.

PHY 4373 Introductory Nuclear and Particle Physics (3)
Pre-requisite(s): PHY 3373
Topics normally include: nuclear structure and models; angular momentum and isospin; conservation laws and discrete symmetries; electromagnetic and weak interactions; quark model; nuclear and particle astrophysics.

PHY 4374 Introduction to Relativistic Quantum Mechanics (3)
Pre-requisite(s): PHY 3373
Dirac's equation, its covariance properties, its solutions; Foldy-Wouthuysen transformation and exact results; propagator theory; applications in various areas of physics.

PHY 5155 Advanced In-Situ Instrumentation Techniques (1)
Cross-listed as ENV 5155
Pre-requisite(s): PHY 4155, 4350, and concurrent enrollment in 4351
Computer modeling and instrument design and development of detectors for the in-situ measurement of physical and dynamic characteristics of dust in interplanetary space and planetary ring systems.

PHY 5180 Graduate Physics Colloquium (1)
Pre-requisite(s): Enrollment in graduate program
Students are required to register for the weekly colloquium and to present papers. No more than three semester hours may be counted on a master's degree and no more than six may be counted on the Ph.D. degree.

PHY 5199 Non-Thesis Degree Completion (1)
To fulfill requirements for non-thesis master's students who need to complete final degree requirements other than coursework during their last semester. This may include such things as a comprehensive examination, oral examination, or foreign language requirement. Students are required to be registered during the semester they graduate.

PHY 5320 Classical Mechanics I (3)
Pre-requisite(s): PHY 4322
Elementary mechanics, variational principles, Lagrange's equations, two-body central forces, scattering, kinematics, rotations, rigid body motion, and Hamilton's equations of motion; special relativity, including covariant Lagrangian formulation.

PHY 5321 Classical Mechanics II (3)
Pre-requisite(s): PHY 5320
Small oscillations; canonical transformations; Hamilton-Jacobi theory; canonical perturbation theory; Lagrangian and Hamiltonian densities, critical points, Lyapunov exponents, bifurcation, chaos, noise, and other topics in non-linear dynamics.

PHY 5330 Electromagnetic Theory I (3)
Pre-requisite(s): PHY 4322 and 5360 (concurrently)
Advanced electrostatics and magnetostatics, boundary-value problems, time-varying fields, conservation laws, plane electromagnetic waves, wave guides and resonant cavities, and simple radiating systems and diffraction.

PHY 5331 Electromagnetic Theory II (3)
Pre-requisite(s): PHY 5330
Magnetohydrodynamics and plasma physics, advanced relativistic electrodynamics, collisions of charged particles, scattering, Lienard-Wiechert potentials and radiation by moving charges, Bremsstrahlung, the method of virtual quanta, dynamic multipole fields, radiation damping, self-fields of a particle, and scattering and absorption by a bound system.

PHY 5340 Statistical Mechanics (3)
Pre-requisite(s): PHY 4340 and credit or concurrent registration in PHY 5360
Probability, statistical methods, classical and quantum statistical mechanics, postulates, ensembles, ideal systems, real gases, cluster expansions, liquid helium, and phase transitions.

PHY 5342 Solid State Physics (3)
Pre-requisite(s): PHY 4372 and 5370
Theory of solids: crystal symmetry, lattice dynamics, band theory, lattice defects, impurity states. Applications to the thermal, magnetic, and electrical properties of solids.

PHY 5350 Fundamentals of Stellar Structure and Evolution (3)
Pre-requisite(s): PHY 4350 and 4351
Stellar structure, hydrostatic equilibrium, radiative transfer, stellar surface phenomena, and corona interactions. Cosmical electrodynamics and nuclear reactions in astrophysics, basic stellar evolution, variable stars, degenerate cores, white dwarfs, and neutron stars.

PHY 5351 General Relativity (3)
Pre-requisite(s): PHY 5360
A systematic exposition of Einstein's general theory of relativity, with emphasis on applications to astrophysical and cosmological problems.

PHY 5352 Space Plasma Physics (3)
Pre-requisite(s): PHY 4322 and 5360 (concurrently) or consent of the instructor
Space plasma and electromagnetic field phenomena; the guiding center drift equation (with applications); adiabatic invariant theory; the basic equations of magnetohydrodynamics; plasma convection, currents (including Chapman-Ferraro currents and ring currents), oscillations; magnetohydrodynamic boundaries, diffusion, waves, shocks, and instabilities.

PHY 5360 Mathematical Physics I (3)
Pre-requisite(s): MTH 2321 and 3325
Theory of analytical functions, Laplace and Fourier transforms, Fourier series, theory of distributions, ordinary differential equations, eigenvalue problems, special functions defined by eigenvalue problems, Green's functions, partial differential equations, radiation problems and scattering problems.

PHY 5361 Mathematical Physics II (3)
Pre-requisite(s): PHY 5360 or consent of instructor
Conformal mapping, electrostatic problems, dispersion relations, asymptotic expansions, method of steepest descent, calculus of variations, Rayleigh-Ritz principle, finite-dimensional vector spaces, matrix theory, orthogonal transformations, normal coordinates, Hilbert vector spaces, unitary transformations, resolvent operators, operator calculus, integral equations, and approximate methods for solution of boundary value problems.

PHY 5370 Quantum Mechanics I (3)
Schrodinger equation, eigenfunctions and eigenvalues, harmonic oscillator, and hydrogen atom. WKB approximation, collision theory, matrix formulation of quantum mechanics, transformation theory, and representation theory, including Schrdinger and Heisenberg picture.

PHY 5371 Quantum Mechanics II (3)
Pre-requisite(s): PHY 5370
Angular momentum algebra, Pauli Principle, many-particle systems, conservation laws, symmetry principles, time-dependent approximation methods, time-independent approximation methods, atoms, molecules, and relativistic wave equations.

PHY 5381 Special Topics in Physics (3)
Pre-requisite(s): Consent of instructor and the departmental adviser
Selected topics in physics. May be repeated once with change of content.

PHY 5V95 Graduate Research (1-9)
Pre-requisite(s): Consent of student's research supervisor and departmental adviser
The research is intended for those students who have not yet passed the Ph.D. qualifying examination and who have not yet selected a Ph.D. dissertation topic. May be repeated for no more than twelve semester hours of credit. (Not to be counted on master's degree). (0-9) or

PHY 5V99 Thesis (1-6)
Pre-requisite(s): Twelve semester hours of graduate work and consent of the department

PHY 6350 Relativistic Astrophysics (3)
Pre-requisite(s): PHY 5350 and 5351
Relativistic astrophysics, and the final stages of stellar evolution; supernovae, binary stars, accretion disks, pulsars; extragalactic radio sources; active galactic nuclei; compact objects.

PHY 6351 Cosmology (3)
Pre-requisite(s): PHY 5350 and 5351
Cosmology: extragalactic distance determinations; relativist relativistic cosmological models; galaxy formation and clustering; thermal history of the universe, microwave background; cosmological tests, advanced topics in general relativity.

PHY 6352 High-Energy Astrophysics (3)
Pre-requisite(s): PHY 5330, 5340, 5360 and 5370
Radiative transfer, scattering, the interaction of matter and radiation, atomic and molecular structure, magnetodrodynamics and plasma physics, accretion disks and spiral density waves.

PHY 6370 Advanced Quantum Mechanics (3)
Pre-requisite(s): PHY 5371
Identical particles and symmetry, self-consistent field theory, spin and angular momenta, electromagnetic interactions, semiclassical radiation theory, many-body perturbation theory, topics in scattering theory. Applications to atomic, molecular, and nuclear systems.

PHY 6371 Relativistic Quantum Mechanics (3)
Pre-requisite(s): PHY 5371
Klein-Gordon equation, Dirac equation, solutions of Dirac equation for scattering and bound states, non-relativistic limits of Dirac solutions, hole theory, Feynman diagrams, quantum electrodynamics, renormalization procedures, non-electromagnetic processes, solutions.

PHY 6372 Elementary Particle Physics (3)
Pre-requisite(s): PHY 5371
Basic concepts of elementary particle physics; symmetries, groups, and invariance principles; hadron-hadron interactions; static quark model of hadrons; weak interactions; brief introduction to quantum chromodynamics.

PHY 6373 Quantum Field Theory I (3)
Pre-requisite(s): PHY 4374, 5370, 5371, or 6371; or consent of instructor
Second quantization of free fields; second quantization of interacting fields; elementary processes - Q.E.D. and non-Q.E.D. examples; perturbation theory methods for higher order processes; renormalization theory; path integral realization of quantum field theory.

PHY 6374 Quantum Field Theory II (3)
Pre-requisite(s): PHY 6373
Modern formulation of quantum field theory: quantization and renormalization of gauge theories, both Abelian and non-Abelian; third quantization; applications in the Q.E.D. example; SU2L XU1 theory; quantum chromodynamics; grand unified theories; theories of everything including quantum gravity such as the superstring theory.

PHY 6375 Quantum Field Theory III (3)
Pre-requisite(s): PHY 6374
Continuation of 6374: Detailed theory of higher order corrections to Standard Model and beyond the Standard Model processes; detailed presentation of recent developments in superunification, superstring/M theory, superstring field theory, and other approaches to quantum general relativity, depending on instructor. May be repeated for credit by instructor for a maximum of nine credits.

PHY 6380 Special Topics in Advanced Physics (3)
Pre-requisite(s): Consent of student's graduate committee
Special topics which are related to specialized fields of research sponsored in the department. May be repeated once with change of content.

PHY 6V00 Dissertation Proposal (1-9)
Pre-requisite(s): Permission of Physics Graduate Program Director
Research for doctoral students studying for preliminary examinations or preparing their dissertation topic proposals.

PHY 6V99 Dissertation (1-12)
Pre-requisite(s): Consent of the student's supervisory committee and admission to candidacy
A minimum of twelve semester hours is required.