Physics and Astrophysics

M.S. in Physics and Astrophysics (https://catalog.und.edu/graduateacademicinformation/departmentalcoursesprograms/physicsandastrophysics/phy-ms/)

Ph.D. in Physics and Astrophysics (https://catalog.und.edu/graduateacademicinformation/departmentalcoursesprograms/physicsandastrophysics/phy-phd/)

PHYS 501T. Mathematical Methods in Physics for Teachers. 2 Credits.
This course aims to cover a broad spectrum of mathematical techniques that are essential to solve advanced problems in physics. The course includes a review of calculus, differential equations, linear algebra and Hilbert space theory, complex variables, vector analysis, eigenvalue problems, Green's functions, Fourier Series, integral transforms, and special functions. Various illustrative examples from electrodynamics, quantum, classical, and statistical mechanics will be given. Applicability of different approaches to the solution of problems in physics will be emphasized through in-class examples and homework. Prerequisite: MATH 165 or equivalent. F, odd years.

PHYS 502T. Physics I for Teachers. 3 Credits.
An in-depth calculus-based study of linear and non-linear motion using Newtonian mechanics, energy methods, and Lagrangian mechanics. Static equilibrium, gravitation, oscillations, fluid statics and dynamics, and thermodynamics will also be studied. Applying systematic problem solving techniques designed to efficiently solve complex problems is an important part of the course. Exploring concept mapping, lesson planning, and developing content for a dual-credit course are integral parts of the course. Familiar applications and relevant current developments will be emphasized through in-class examples and homework. Prerequisite: MATH 165. F, odd years.

PHYS 503T. Physics II for Teachers. 3 Credits.
An in-depth calculus-based study of electric and magnetic fields, waves and light, AC and DC circuits. Maxwell's equations will be studied in integral and differential form. Problem solving techniques will be presented accompanied by specialized mathematical solutions. Geometric optics, including ray diagrams and images will also be studied. Applications to both fields and light will be presented. Prerequisite: PHYS 502T. S, even years.

PHYS 504T. Physics III for Teachers. 2 Credits.
This course aims to give its students a deeper understanding of modern physics in a way that can be connected to material taught in high school and introductory college classes. The course reviews special relativity and quantum physics, with special attention to conceptual and philosophical aspects such as wave-particle duality and various interpretations of quantum mechanics. The course discusses applications of relativity and quantum mechanics to atoms, molecules, solids, particles, and nuclei, with special attention to subtleties and common misconceptions. Prerequisite: PHYS 503T. S, even years.

PHYS 505TL. Physics I/II/III for Teachers Laboratory: Online. 2 Credits.
20-25 laboratory simulations will be conducted. The laboratory simulations range from Newtonian physics to radioactive decay. The laboratory simulations will cover selected topics from PHYS 502T, 503T, and 504T. Prerequisite: PHYS 504T. SS, even years.

PHYS 506T. Conceptual Classical Mechanics for Teachers. 2 Credits.
The goal of the course is to familiarize its students to upper-level classical mechanics in a way that they can visualize the connection to mechanics being taught in high school and introductory college classes. The course is designed to expose the student to Lagrangian and Hamiltonian formulation of classical mechanics, Euler's rigid body equations of motion, canonical perturbation theory, and deterministic chaos theory. These methods are applied to force-free motion of a rigid body, oscillations of systems of coupled particles, and central force motion including the Kepler problem and scattering in a Coulomb potential. A philosophical discussion of the evolution of the field over the last four centuries will be embedded in the course. Familiar applications and relevant current developments will be emphasized through in-class examples and homework. Prerequisite: PHYS 502T. F, even years.

PHYS 507T. Conceptual Electromagnetism for Teachers. 2 Credits.
This course aims to give its students a deeper understanding of electricity and magnetism in a way that can be connected to material taught in high school and introductory college classes. The course reviews selected topics in electrostatics, magnetostatics, classical electrodynamics, special relativity, and electromagnetism-matter interactions, and a qualitative overview of quantum electrodynamics. The course focuses on qualitative, conceptual, and philosophical aspects of electromagnetism. These include mechanical analogues, paradoxes and pitfalls, action-at-a-distance, causality, relativistic covariance, gauge invariance, photon behavior, and Feynman diagrams. Familiar applications and relevant current developments will be emphasized through in-class examples and homework. Prerequisite: PHYS 504T. S, odd years.

PHYS 508T. Conceptual Quantum Physics for Teachers. 2 Credits.
This course introduces fundamental concepts of quantum mechanics by developing a complete modern theoretical formalism. It covers a variety of important topics including the fundamental principles of quantum mechanics, essential mathematical tools (Dirac notation), angular momentum, the harmonic oscillator, the hydrogen atom, time evolution of quantum systems and perturbation theory. Applications to solid-state theory, lasers, quantum optics, nuclear and particle physics, materials research, and information technologies will be included. Prerequisite: PHYS 504T. S, odd years.

PHYS 509. Methods of Theoretical Physics. 3 Credits.
An introduction to the mathematical methods currently used in physics.

PHYS 510. Methods of Theoretical Physics. 3 Credits.
A continuation of Physics 509 introduction to the mathematical methods currently used in physics.

PHYS 511A. Physics for Teachers I. 3 Credits.
Prerequisite: PHYS 511L.

PHYS 511B. Physics for Teachers I. 3 Credits.
Prerequisite: PHYS 511A.

PHYS 511L. Physics for Teachers I Lab. 2 Credits.
Prerequisite: Department consent.

PHYS 512A. Physics for Teachers II. 3 Credits.
Prerequisite: PHYS 512L.

PHYS 512B. Physics for Teachers II. 3 Credits.
Prerequisite: PHYS 512A.

PHYS 512L. Physics for Teachers II Lab. 2 Credits.
Prerequisite: PHYS 511L and PHYS 511B.

PHYS 513A. Physics for Teachers III. 3 Credits.
Prerequisite: PHYS 513L.

PHYS 513B. Physics for Teachers III. 3 Credits.
Prerequisite: PHYS 513A.

PHYS 513L. Physics for Teachers III Lab. 2 Credits.
Prerequisite: PHYS 512L and PHYS 512B.

PHYS 520. Cosmology. 3 Credits.
Cosmology is the study of the origin, structure, and evolution of the Universe. This graduate-level course will provide an overview of recent developments in cosmology, including; the Big Bang model, inflation, the cosmic microwave background, baryogenesis, the expanding universe, Hubble's constant and the distance scale, and dark energy. On demand.

PHYS 525. Galaxies. 3 Credits.
This graduate-level course will provide an overview of the formation and evolution of galaxies. Topics include; galaxy classification, formation of spheroids and disk galaxies, galactic dynamics, interstellar medium, dark matter, mass models, spiral structure formation, large-scale structure, and high redshift galaxies. On demand.

PHYS 535. Solid State Physics. 3 Credits.
The crystal lattice, electron theory of metals and semiconductors, and transport phenomena in solids.

PHYS 536. Solid State Physics II. 3 Credits.
Lattice vibrations, phononelectron interactions, and cooperative phenomena in solids.

PHYS 539. Quantum Mechanics. 3 Credits.
The Schroedinger equation, perturbation methods, and simple quantum mechanical systems.

PHYS 540. Quantum Mechanics. 3 Credits.
Matrix methods, spin, and scattering phenomena.

PHYS 541. Theory Electricity Magnetism. 3 Credits.
Electrostatics, magnetostatics, electromagnetic waves.

PHYS 542. Theory of Electricity and Magnetism. 3 Credits.
Special theory of relativity, scattering of charged particles, and radiation.

PHYS 543. Statistical Physics. 3 Credits.
The Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics, and their application to the description of physical systems.

PHYS 545. Analytical Mechanics. 3 Credits.
Variational methods. Lagrange's equations, oscillations, Hamilton equations, and special relativity.

PHYS 549. Seminar. 1 Credit.
Repeatable to 3.00 credits.

PHYS 550. Special Topics. 1-3 Credits.
Investigation of special topics in advanced physics; the subject matter determined by studentfaculty interest. Prerequisite: Consent of department. Repeatable to 6.00 credits.

PHYS 590. Research. 1-16 Credits.
Repeatable.

PHYS 996. Continuing Enrollment. 1-12 Credits.
Repeatable. S/U grading.

PHYS 997. Independent Study. 2 Credits.
.

PHYS 998. Thesis. 1-9 Credits.
Repeatable to 9.00 credits.

PHYS 999. Dissertation. 1-18 Credits.
Repeatable to 18.00 credits.

Undergraduate Courses for Graduate Credit

PHYS 402. Computational Physics. 3 Credits.
Computer applications in physics, that may include data analysis, numerical simulation, symbolic and algebraic programming, parallel computing, computer interfacing and/or experimental physics applications. Prerequisite: PHYS 252 and knowledge of a higher-level computer programming language, or consent of instructor. On demand.

PHYS 428. Advanced Physics Laboratory. 2 Credits.
Advanced undergraduate experiments in physics, using modern techniques and instrumentation. Classic experiments leading to the current understanding of physical theory. Prerequisite: PHYS 253 or approval of instructor. F, odd years.

PHYS 431. Quantum Mechanics I. 3 Credits.
An introduction to quantum mechanics with applications to atomic structure. Prerequisite: PHYS 253. Prerequisite or Corequisite: PHYS 317 or approval of department. F, even years.

PHYS 432. Quantum Mechanics II. 3 Credits.
Further development of basic quantum theory with application to atomic, molecular, solid state and nuclear physics. Prerequisite or Corequisite: PHYS 431 or consent of instructor. S, odd years.

PHYS 434. Nuclear Physics. 3 Credits.
Introduction to the theory of atomic nuclei, fundamental forces and sub-atomic particles. Prerequisite: PHYS 253 or approval of instructor. F, odd years.

PHYS 437. Introductory Solid State Physics. 3 Credits.
A general introduction to solid state phenomena. Prerequisite: PHYS 253 or approval of instructor. F, even years.

PHYS 460. Introduction to Astrophysics. 3 Credits.
Nature of stars. Topics include celestial mechanics, relativity, optics, stellar birth, stellar interiors and evolution, nucleosynthesis, stellar death, compact objects, black holes, neutron stars, white dwarfs, binaries and variable stars. Some topics include the use of computer tools to solve problems. Prerequisite: PHYS 253 or approval of instructor. F, even years.

PHYS 461. Introduction to Astrophysics II. 3 Credits.
Galaxies and the universe. Topics include structure and evolution of galaxies, the Milky Way, stellar populations, globular clusters, interstellar medium, big bang, Hubble and the distance scale, radio galaxies, quasars, jets, blazars, clusters and superclusters of galaxies and cosmology. Some topics include the use of computer tools to solve problems. Prerequisite: PHYS 460 or approval of instructor. S, odd years.

PHYS 492. Special Problems. 1-3 Credits.
Selected problems in physics or astrophysics. Prerequisite: Approval of the department. Repeatable to 9.00 credits. On demand.