Physics Courses

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 Physics
Hours: 3
A study of theoretical and applied aspects of atomic structure. Topics include atomic models, 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 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 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.