PHYSICS

Professors Bunch, Ditteon, Duree, Joenathan, Kirkpatrick, Kirtley, McInerney, Moloney, Siahmakoun, Syed, Wagner, West, and Western.

NOTE: In courses which include a laboratory, satisfactory completion of the laboratory work is required in order to pass the course.

PH 111  Physics I  3 1/2 R-1 1/2-4C  F,W  Coreq: MA 111

Newton's laws of motion, gravitation, Coulomb's law, Lorentz force law, Strong and weak nuclear forces, conservation of energy and momentum, torque and angular momentum, relevant laboratory.

PH 112  Physics II  3 1/2R-1 1/2L-4C  W,S  Pre: PH 111 and MA 111; Co: MA 112

Oscillations, one-dimensional waves, introduction to quantum mechanics, electric fields and potentials, electric current and resistance, DC circuits, capacitance, relevant laboratory experiments.

PH 113  Physics III  3 1/2R-1 1/2L-4C  S,F  Pre: PH 112 and MA 112; Coreq: MA 113

Sources of magnetic fields, Faraday's law, inductance electromagnetic waves, reflection and polarization, geometric and physical optics, introduction to relativity, relevant laboratory experiments.

PH215  Introduction to CHAOS  2R-0L-2C  W

What constitutes chaotic behavior, detection of chaos in real systems using phase space plots, Poincare sections, bifurcation plots, power spectra, Lyapunov exponents, and computer simulation of chaotic systems.

PH 230  Introduction to Astronomy and Astrophysics  3R-3L-4C  F  Pre: MA 111, and PH 111 or EM 120

Celestial coordinates; electromagnetic radiation, atomic structure, spectra, blackbody radiation and radiative transfer as they relate to astronomy; telescopes and detectors; structure and evolution of stars; galaxies; cosmology; quantitative observational work using modern telescopes, detectors and software simulations.

PH 235  Many-Particle Physics  3 1/2R-1 1/2L-4C  F  Pre: PH 111 or Coreq: EM 202; and Coreq: MA 112

Dynamics of rigid body, harmonic motion; mechanics of fluids; heat, kinetic theory, thermodynamics. Alternate week laboratories.

PH 255  Foundations of Modern Physics  3 1/2R-1 1/2L-4C  S  Pre: PH 113 and MA 221

Wave-particle nature of matter and radiation, Bohr model, Schrodinger equation, quantum description of the hydrogen atom, atomic and molecular spectra, and introduction to statistical physics.

PH 265  Fundamentals of Nuclear Physics and Radiation  3R-3L-4C  S  Pre: PH 112, and MA 221
Relativity, black-body radiation, the Bohr model, physics of the nucleus, fission and fusion, reactors, nuclear radiation, radiation damage, medical applications.

**PH 270 Special Topics in Physics**  Credit arranged  Pre: Consent of instructor

Lectures on special topics in physics. Maximum of 4 credits per term.

**PH 290 Directed Research**  Credit arranged  Pre: Consent of instructor

Research for freshmen and sophomore students under the direction of a physics and applied optics faculty member. May earn up to a maximum of 2 credits for meeting the graduation requirements. The student must make arrangements with a physics faculty member for the research project prior to registering for this course.

**PH 302 Biophysics**  4R-0L-4C  W  Pre: PH 113 or consent of instructor

Biological examples of the interaction of radiation and matter; medical uses of x-rays, nuclear medicine, magnetic resonance imaging, and current applications in biophysics.

**PH 310 Introduction to Relativity**  2R-0L-2C  F  Pre: PH 113 or consent of instructor

Experimental background of the special theory of relativity, the structure of the theory and its consequences in measurements involving space, time and motion. Relativistic mechanics, relativity and electromagnetism, and applications in modern physics.

**PH 314-15 Theoretical Mechanics I-II**  4R-0L-4C  F, Arranged  Pre: PH 111, PH 235, MA 222

Statics and dynamics of particles and systems of particles, including rigid bodies. Conservation of energy, linear and angular momentum. Central forces. Lagrangian and Hamiltonian equations of motion. Vibrations.

**PH 316 Electric and Magnetic Fields**  4R-0L-4C  F  Pre: PH 113, MA 222

Maxwell’s equations in integral and point form, vector calculus; electric field and potential, electric fields in matter, boundary conditions; the magnetic field.

**PH 317 Electromagnetism**  4R-0L-4C  W  Pre: PH 316

Further methods in electrostatics, Poisson’s equation; magnetostatics, the vector potential; electromagnetic induction; magnetic properties of matter; further applications of Maxwell’s equations, properties of electromagnetic radiation.

**PH 322 Celestial Mechanics and Solar System Physics**  4R-0L-4C  F [2001-02]  Pre: PH 112 or PH 265

Equation of motion of the two-body problem and their integrals; artificial satellites, orbit theory and perturbation theory; physical properties of the planets and their satellites, the sun and interplanetary space, and the origin of the solar system.

**PH 325 Advanced Physics Laboratory I**  2R-6L-4C  S  Pre: PH 255 or PH 265
Introduction to the methods of experimental physics; topics may include error analysis, component fabrication, transducers, ac circuits, operational amplifiers, electrical signal conditioning, and automated data acquisition.

**PH 326 Advanced Physics Laboratory II** 2R-6L-4C  F  Pre: PH 325

Selected experiments in mechanics, sound, optics, heat, electricity, nuclear, and solid-state physics.

**PH 327 Thermodynamics and Statistical Mechanics** 4R-0L-4C  F[2000-01]  Pre: PH 235 or Consent of instructor


**PH 330 Material Failure** 3R-3L-4C  Pre: PH 113

Physical principles of instrumentation used for material failure analysis, including light microscopy, electron microscopy, and spectroscopy. Laboratory includes experiments and case studies using these instruments.

**PH 401 Introduction to Quantum Mechanics** 4R-0L-4C  W  Pre: PH 255, or PH 113 and PH 265

Review of wave-particle experiments, atomic model, Bohr theory, deBroglie's hypothesis. Uncertainty principle, Schroedinger equation, quantum mechanical operators and stationary states, quantization and role of angular momentum.

**PH 402 Introduction to Atomic Physics** 4R-0L-4C  S[2001-02]  Pre: PH 401

Solutions of Schroedinger equation, perturbation theory, applications to one electron system. Quantum numbers, spin and magnetic moments, multi-electron systems including LS coupling. Zeeman effect, transition rates, hyperfine structure, X-rays.

**PH 404 Acoustics** 4R-0L-4C  Pre: PH 113 and MA 222

Harmonic motion, waves on strings, membranes, eigenfunctions and eigenvalues; waves in rods and fluids; behavior of waves at interfaces; radiation from vibrating piston; resonators, absorption.

**PH 405/PH505 Semiconductor Materials and Devices I** 3R-3L-4C  F  Pre: PH 113 or PH 255 or PH 265

Material structure electronic levels and energy bands; semiconductor doping; optical and electronic material characteristics; p-n junction and diode characteristics; bipolar junction transistor; basics of device fabrication. Laboratories on X-ray and Scanning Electron Microscope investigations, device characteristics and a three-week design project on production and testing of thin films. For graduate credit, students will have to do project work on a topic selected by the instructor.

**PH 406/PH506 Semiconductor Materials and Devices II** 3R-3L-4C  Pre: PH 405 or ECE 250
Metal-semiconductor interfaces; photoresist and photolithography; thin film deposition; design and fabrication of semiconductor diodes; characterization of process diodes and transistors; MOSFETS; optoelectronic devices and lasers. Laboratory is a design project, the production and characterization of a diode, bipolar transistor and MOSFET. The project is a team exercise. For graduate credit, students must do additional project work on a topic selected by the instructor.

PH 407 Solid State Physics  4R-0L-4C  S [2000-01]  Pre: PH 255 or PH 265

Selected topics in the field are discussed in detail; e.g., crystal structures, lattice vibrations and electronic band structure; electrical, optical and thermal properties of solids and semiconductors; and the properties of materials at very low temperatures.

PH 408/PH508 Microsensors  3R-3L-4C  S  Pre: Jr or Sr standing, and consent of instructor

Introduction to solid state materials and conventional silicon processing. Measurement of signals from resistance- and capacitance-based transducers; sensor characteristics, calibration and reliability. Examples of microsensors: thermal, radiation, mechanical, chemical, optical fibers, and biological. For graduate credit, students will have to do project work on a topic selected by the instructor.

PH 425 Advanced Physics Laboratory III  0R-8L-4C  W  Pre: PH 326

Selected experiments in various areas of physics, with primary emphasis on nuclear physics and a significant independent student project

PH 437/ECE480 Introduction to Image Processing  3R-3L-4C  S  Pre: MA 222, and Junior/Senior/Graduate Standing

Basic techniques of image processing. Discrete and continuous two dimensional transforms such as Fourier and Hotelling. Image enhancement through filtering and histogram modification. Image restoration through inverse filtering. Image segmentation including edge detection and thresholding. Introduction to image encoding. Integral laboratory.

PH 440 X-rays and Crystalline Materials  2R-6L-4C  S [2001-02]  Pre: PH 255 or PH 265

X-ray emission, absorption, fluorescence, and diffraction. Methods of analyzing crystalline solid materials. Applications in solid-state physics, materials science, chemistry, metallurgy, and biology.

PH 450 Laser Physics and Applications  3R-3L-4C  S  Pre: PH 255 or PH 265, AO 292 and MA 222, or consent of instructor

Laser safety; Gaussian beam propagation; cavity design; longitudinal and transverse modes; stimulated emission; population inversion; rate equations; gain and threshold; Q-switching and mode-locking; types of laser systems; laser applications in communication; medicine, military, industry.

PH 460 Directed Study  Credit arranged  Pre: Consent of instructor

Permits study in an area of physics not available in regular course offerings. Maximum of 4 credits per term.

PH 470 Special Topics in Physics  Credit arranged  Pre: Consent of instructor
Lectures on special topics in physics. Maximum of 4 credits per term.

**PH 480  Seminar  0C Arranged**
Lectures by staff, Students, and outside speakers on topics of special interest.

**PH 490  Directed Research  Credit arranged  Pre: Consent of instructor**
Research for junior and senior students under the direction of a physics and applied optics faculty member. May earn a maximum of 8 credits between PH 290 and PH 490 for meeting graduation requirements. Maximum of 4 credits per term. The student must make arrangements with a physics and applied optics faculty member for the research project prior to registering for this course.

**PH 497, PH 498, PH 499  Senior Thesis  2C  F,W,S  Pre: Consent of PHAO faculty**
Literature search, research proposal preparation, and laboratory project work. This sequence is designed to result in a completed senior thesis.

**GRADUATE COURSES**

*Note:* SR/GR standing is required for enrolling in the following 500-level courses.

**PH 512  Methods of Mathematical Physics  4R-0L-4C Arranged**

**PH 514  Quantum Mechanics  4R-0L-4C Arranged**
Development of quantum mechanical theory to the present time. Examples from spectroscopy, chemistry, nuclear physics.

**PH 530  Advanced Acoustics  4R-0L-4C Arranged  Pre: PH 404**

**PH 537/ECE 582  Advanced Image Processing  3R-3L-4C  S  Pre: PH 437/ECE 480**
Introduction to color image processing and image recognition. Morphological methods, feature extraction, advanced segmentation, detection and registration, recognition and interpretation. Integral laboratory.

**PH 538 Introduction to Neural Networks  3R-3L-4C Arranged  Pre: Senior or Graduate standing**

**PH 540  Computer Physics  3R-3L-4C Arranged  Pre: Consent of instructor**
Exploration of physics by simulation including planetary motion, waves, chaos, cellular automata and fractals; application of numerical methods of differentiation and integration; computer hardware and machine language as it affects laboratory use; curve fitting and smoothing of data.