Physics (PHYS)

Courses

PHYS 500V. Laboratory and Classroom Practices in Physics. 1-3 Hour.
The pedagogy of curricular materials. Laboratory and demonstration techniques illustrating fundamental concepts acquired through participation in the classroom as an apprentice teacher. May be repeated for up to 3 hours of degree credit.

PHYS 5011. Introduction to Current Physics Research Seminar. 1 Hour.
This seminar course introduces new Physics graduate students to the faculty of the Physics department and their current research efforts. In addition, the students will be introduced to scientific ethics, and learn communication skills.

PHYS 502V. Individual Study in Advanced Physics. 1-4 Hour.
Guided study in current literature. May be repeated for up to 4 hours of degree credit.

PHYS 5033. Design and Fabrication of Scientific Apparatus. 3 Hours.
Students will learn mechanical and electronic techniques used in the design and fabrication of scientific apparatus. (This course cannot be used to satisfy degree requirements in any physics program.)

PHYS 5041. Journal Club Seminar. 1 Hour.
In this seminar, the students will present talks based on published research articles. The goal of the course is to develop oral communication skills in the students. Effective literature search techniques will also be covered.

PHYS 5073. Mathematical Methods for Physics. 3 Hours.
This course merges the mathematics required in classical mechanics, electrostatics, magnetostatics, and quantum mechanics into a single course. The goal is to develop physics problem-solving skills, a strong mathematical foundation, and a more unified picture of physics.

PHYS 5083. Mathematical Methods of Physics II. 3 Hours.
Applications of matrices, tensors, and linear vector spaces to problems in physics. Introduction to groups and their representations, and symmetry principles in modern physics. Prerequisite: PHYS 5073.

PHYS 5093. Applications of Group Theory to Physics. 3 Hours.
Application of group theory to topics in physics, especially to atomic/molecular and solid-state physics. Prerequisite: PHYS 5073.

PHYS 5103. Advanced Mechanics. 3 Hours.

PHYS 5111. Research Techniques Through Laboratory Rotations. 1 Hour.
Graduate students will be introduced to detailed operational aspects of two Physics research laboratories through extensive observation of those laboratory's operations during a six week rotation through each lab. Planning for starting a research project in the summer will take place in the final three week rotation period.

PHYS 5213. Statistical Mechanics. 3 Hours.
Classical and quantum mechanical statistical theories of matter and radiation. Prerequisite: PHYS 4333 and (PHYS 4073 or PHYS 5413).

PHYS 5263L. Experiment and Data Analysis. 3 Hours.
This course is devoted to learning some of the frequently used experimental techniques and methods by which experimental data are analyzed to extract quantitative information on physical parameters. Students will perform experiments, analyze data, and write lab reports. Pre- or Corequisite: PHYS 5423. Prerequisite: Graduate standing or instructor consent.

PHYS 5313. Advanced Electromagnetic Theory I. 3 Hours.
Electrostatics, boundary-value problems in electrostatics, electrostatics in a medium, magnetostatics, and Faraday's Law.

PHYS 5323. Advanced Electromagnetic Theory II. 3 Hours.
Maxwell equations, conservation laws, wave propagation, waveguides, radiating systems, scattering, special relativity, and radiation by moving charges.

PHYS 5363. Scientific Computation and Numerical Methods. 3 Hours.
An introduction to numerical methods used in solving various problems in engineering and the sciences. May not earn credit for this course and MATH 4353 or MATH 4363. This course is cross-listed with MATH 5363.

PHYS 5413. Quantum Mechanics I. 3 Hours.
Non-relativistic quantum mechanics; the Schrodinger equation; the Heisenberg matrix representation; operator formalism; transformation theory; spinors and Pauli theory; the Dirac equation; applications to atoms and molecules; collision theory; and semiclassical theory of radiation. Prerequisite: PHYS 4073.

PHYS 5423. Quantum Mechanics II. 3 Hours.
Continuation of PHYS 5413 Pre-requisite: PHYS 5413.

PHYS 5513. Atomic and Molecular Physics. 3 Hours.
Survey of atomic and molecular physics with emphasis on the electronic structure and spectroscopy of 1 and 2 electron atoms and diatomic molecules. Includes fine and hyperfine structure, Zeeman and Stark mixing of states, collision phenomena, radiative lifetimes, and experimental techniques. Prerequisite: PHYS 5413.

PHYS 5523. Theory of Relativity. 3 Hours.
Conceptual and mathematical structure of the special and general theories of relativity with selected applications. Critical analysis of Newtonian mechanics; relativistic mechanics and electrodynamics; tensor analysis; continuous media; and gravitational theory.

PHYS 5613. Introduction to Biophysics and Biophysical Techniques. 3 Hours.
Origins of biophysics, biological polymers and polymer physics, properties of DNA and proteins, techniques to study DNA and proteins, biological membrane and ion channels, biological energy, experimental techniques to study single DNA and proteins. Two experiments are included: (1) DNA Gel electrophoresis; (2) Measurement of double-stranded DNA melting point.

PHYS 5653. Subatomic Physics. 3 Hours.

PHYS 5713. Condensed Matter Physics I. 3 Hours.
The course covers the Drude theory and the Sommerfeld theory of metals, crystal lattices, reciprocal lattices, X-ray diffraction, Bloch's theory of electrons in periodic potential, formation of band gap, lattice vibration, and cohesive energy in solids. Prerequisite: PHYS 5413.

PHYS 5723. Physics at the Nanoscale. 3 Hours.
This is a cross-disciplinary course that is focused on teaching nanoscience and engineering by studying surface science, the building and analysis of quantum-confined structures, and related nano manufacturing processes. Students will achieve an integrated knowledge of the concepts of surface science, quantum mechanics, nano processing and manipulation, and techniques of materials research.

PHYS 5734. Laser Physics. 4 Hours.
A combined lecture/laboratory course covering the theory of laser operation, laser resonators, propagation of laser beams, specific lasers such as gas, solid state, semiconductor and chemical lasers, and laser applications.

PHYS 5753. Applied Nonlinear Optics. 3 Hours.
Topics include: practical optical processes, such as electro-optic effects, acousto-optic effects, narrow-band optical filters, second harmonic generation, parametric amplification and oscillation, and other types of nonlinear optical spectroscopy techniques which are finding current practical applications in industry.
PHYS 5763. Experimental Methods for Nanoscience. 3 Hours.
Fundamentals of the selected techniques suitable for characterization on the nanoscale. Focus on diverse methods such as x-ray and neutron spectroscopy, scanning probe microscopies, optical methods, electron diffraction methods and more.

PHYS 5773. Introduction to Optical Properties of Materials. 3 Hours.
This course covers crystal symmetry optical transmission and absorption, light scattering (Raman and Brillouin) optical constants, carrier mobility, and polarization effects in semi-conductors, quantum wells, insulators, and other optically important materials.

PHYS 5783. Physics of 2D Materials. 3 Hours.
Introduction to the structures of all known layered materials, followed by mechanical, electronic, spin, optical, and topological properties of two-dimensional materials. Discussion of theoretical concepts and examination of experimental manifestations of those concepts are interwoven throughout the semester. Knowledge of solid state physics is required. Corequisite: PHYS 5413.

PHYS 588V. Selected Topics in Physics. 1-3 Hour.
Selected topics in experimental or theoretical physics at the advanced level. May be repeated for up to 6 hours of degree credit.

PHYS 590V. Master of Arts Research. 1-6 Hour.

PHYS 600V. Master of Science Thesis. 1-6 Hour.
Master of Science Thesis. May be repeated for degree credit.

PHYS 6413. Quantum Mechanics III. 3 Hours.
Relativistic quantum mechanics, second quantization, with applications to quantizing electromagnetic fields and to many-body theory. Introduction to Feynman diagrams. Prerequisite: PHYS 5423.

PHYS 6513. Advanced Topics in Complexity. 3 Hours.
The goal of the course is to give students tools to investigate the behavior of complex systems and to analyze the relationship of non-linear dynamics and chaos theory to complex biological and non-biological systems. A special emphasis will be given to understanding the way neurons work as biological computing elements.

PHYS 6613. Quantum Optics. 3 Hours.
Properties of light and its interaction with atoms, particular attention given to the laser and recent experiments. Classical theory of resonance; Optical Bloch Eqs.; 2 level atoms in steady fields; pulse propagation; semiclassical theory of the laser, coherent states and coherent functions; gas, solid, and dye lasers; photon echoes and superradiance; quantum electrodynamics and spontaneous emission. Prerequisite: PHYS 5413 or equivalent.

PHYS 6713. Condensed Matter Physics II. 3 Hours.
The course covers surface physics, physics of homogeneous and inhomogeneous semiconductors, dielectric and ferroelectric physics, defects in crystals, spin interaction and magnetic properties, superconductivity, and band structure calculation. Prerequisite: PHYS 5713 and PHYS 5413.

PHYS 700V. Doctoral Dissertation. 1-18 Hour.
Doctoral Dissertation. May be repeated for degree credit.