

PHYSICS (PHYS)

PHYS 566 Directed Studies (3-4 Credits)

No credits earned in this course may be applied to the number of credits required to satisfy graduate degree requirements. This course may be repeated for credit.

PHYS 581 Topics in Physics (1-3 Credits)

Special topics of current interest. This course may be repeated for credit when the instructor determines there will not be a duplication of material.

PHYS 600 Independent Study (3 Credits)

Course concerning special topics in physics not covered in regular course offerings. This course may be repeated for credit if instructor determines there will be no duplication of material.

PHYS 601 Classical Mechanics (4 Credits)

The mechanics of particles and rigid bodies, methods of Lagrangian and Hamiltonian mechanics, relativistic mechanics, approximation techniques.

PHYS 603 Mathematical Physics (4 Credits)

Complex variables and analytic functions. Vector spaces (finite dimensional and infinite dimensional), operators and matrix representations.

PHYS 610 Classical Electricity and Magnetism I (4 Credits)

Electrostatics. Solution of boundary value problems. Green's functions and direct solution of Laplace's equation. Magnetostatics and steady currents. Maxwell's equations and plane wave solutions.

PHYS 611 Classical Electricity and Magnetism II (3 Credits)

Waves inside conducting boundaries. Radiation from simple current systems, spherical waves and multipole radiation. Covariant formulation of electromagnetism. Interaction of radiation with matter.

Prerequisite(s): PHYS 610

PHYS 621 Quantum Mechanics I (4 Credits)

Axiomatic development of wave mechanics and the Schroedinger equation in one and three dimensions; wave packets; spin and angular momentum.

PHYS 622 Quantum Mechanics II (4 Credits)

Scattering theory; matrix methods; symmetry; perturbation theory and other approximate methods; identical particles; relativistic wave equations and their applications.

Prerequisite(s): PHYS 621

PHYS 623 Statistical Physics and Thermodynamics (4 Credits)

Statistical ensembles and averages, classical equilibrium, thermodynamics and statistical mechanics, quantum statistics, kinetic theory and transport properties.

Prerequisite(s): PHYS 601 and PHYS 621

PHYS 631 Quantum Optics and Atomics (3 Credits)

This is a graduate-level course designed to introduce the theory, current research topics and applications of Atomic Physics and Quantum Optics. Cross-listed with PHYS 430.

Prerequisite(s): PHYS 621

PHYS 632 Quantum Materials and Quantum Devices (3 Credits)

This is a graduate-level course designed to introduce the basic concepts and methods for the theoretical description of quantum materials and quantum devices. The first part of the course focuses on the electronic properties of quantum materials. In the second part, the concepts of qubit, quantum gate, and quantum sensor are introduced, along with examples of their implementation based on quantum materials. Cross-listed with PHYS 432.

Prerequisite(s): PHYS 621

PHYS 634 Introduction to Plasma Physics (3 Credits)

This course provides an introduction to plasma physics, including where plasmas are found, avenues of current research, and computational methods in the field. The concepts of single-particle motion, fluid equations, magnetohydrodynamics, and waves and instabilities are covered. Cross-listed with PHYS 434.

PHYS 638 Nuclear and Particle Physics (3 Credits)

This course provides an introduction to particle and nuclear physics. Topics include: global properties of nuclei, nuclear stability, nucleon structure, elastic and deep inelastic scattering from nuclei, QCD (quarks and gluons), quarkonia and other mesons, collider physics, weak interaction phenomenology, neutrino oscillations, weak bosons, and the Standard Model. Cross-listed with PHYS 438.

Prerequisite(s): PHYS 621

PHYS 639 General Relativity and Cosmology (3 Credits)

Introduction to general relativity, tensor analysis, gravitational field equations, gravitational waves, Schwarzschild and Kerr solutions, cosmological models, gravitational collapse. Cross-listed with PHYS 439.

PHYS 651 Teaching Physics (2 Credits)

Designed for entering students teaching a lab or tutoring one of our undergraduate courses. Respective faculty will instruct students in relevant ways. This course may be repeated for credit.

PHYS 657 Careers in Physics (1 Credit)

Presentations and discussion of a wide spectrum of career options for physics graduates. Invited speakers from private enterprises, the public sector, and nonprofit organizations will describe opportunities and experiences in their professions. This course may be repeated for credit when the instructor determines there will not be duplication of material.

PHYS 685 Colloquium (0-2 Credits)

Includes presentations by invited speakers on areas of active research in physics. The course also will include an overview of physics research at William & Mary and training in the responsible and ethical conduct of research. No credits earned in this course may be applied to the number of credits required for a degree. This course may be repeated.

PHYS 690 Advanced Topics in Physics (1-4 Credits)

Special topics of current interest. This course may be repeated for credit when the instructor determines there will not be a duplication of material.

PHYS 694 Directed Non-thesis Master's Research (3-12 Credits)

Students design and conduct research on a relevant topic with a faculty advisor. This course may be repeated, but no more than 12 semester credit hours may be used to satisfy degree requirements. Students who are submitting a master's thesis may not use this course to satisfy degree requirements.

PHYS 702 Advanced Mathematical Physics (3 Credits)

Differential equations, Green's functions, some hypergeometric functions, group theory, representation of groups.

PHYS 721 Quantum Field Theory I (3 Credits)

Canonical quantization of scalar, spinor and vector fields; interacting field theories and Feynman diagrams; scattering theory; quantum electrodynamics and introduction to radiative corrections.

Prerequisite(s): PHYS 622

PHYS 722 Quantum Field Theory II (3 Credits)

Functional integral quantization of field theories. Renormalization.

Quantization of gauge theories. Spontaneous Symmetry Breaking and the Higgs mechanism.

Prerequisite(s): PHYS 721

PHYS 741 Condensed Matter Physics (3 Credits)

Introduction to the frontiers of condensed matter physics research; crystal structure, phonons, electrons, electric, optical, and magnetic properties, impurities, elementary excitations, band theory and experimental methods.

Prerequisite(s): PHYS 622 and PHYS 630

PHYS 742 Advanced Condensed Matter Physics (3 Credits)

Selected topics from the frontiers of condensed matter physics research that may include semiconductors, magnetism, superconductivity, topological states of quantum matter. Discussions of modern experimental and theoretical methods.

Prerequisite(s): PHYS 741

PHYS 766 Directed Studies (1-12 Credits)

No credits earned in this course may be applied to the number of credits required to satisfy graduate degree requirements. This course may be repeated.

PHYS 772 The Standard Model of Particle Physics (3 Credits)

Gauge theory. Electroweak interactions and unification. Quantum Chromodynamics. Particle phenomenology.

Prerequisite(s): PHYS 721

PHYS 773 Topics in Nuclear and Particle Physics (3 Credits)

Topics of current interest in strong, electromagnetic and weak interactions; course may be repeated for credit when the instructor determines there will not be duplication of material.

Prerequisite(s): PHYS 772

PHYS 795 Directed Dissertation Research (3-12 Credits)

Students design and conduct research in support of their dissertation under the direction of a faculty advisor. This course may be repeated, but no more than 12 semester credit hours may be used to satisfy degree requirements for a student submitting a dissertation. Students who are not submitting a dissertation may not use this course to satisfy degree requirements.

PHYS 800 Dissertation (1-12 Credits)

Students finish the research for and the writing of their dissertation under the direction of a faculty advisor. This course may be repeated, but no more than 24 semester credit hours may be used to satisfy degree requirements for a doctorate only.