PHYS - PHYSICS

PHYS401 Quantum Physics I (4 Credits)
Introduces some quantum phenomena leading to wave-particle duality. Schroedinger theory for bound states and scattering in one dimension. One-particle Schroedinger equation and the hydrogen atom.
Prerequisite: PHYS371 and PHYS373.
Formerly: PHYS421.

PHYS402 Quantum Physics II (4 Credits)
Quantum states as vectors; spin and spectroscopy, multiparticle systems, the periodic table, perturbation theory, band structure, etc.
Prerequisite: PHYS401.

PHYS404 Introduction to Statistical Thermodynamics (3 Credits)
Introduction to basic concepts in thermodynamics and statistical mechanics.
Prerequisite: PHYS371 or PHYS420.

PHYS405 Advanced Experiments (3 Credits)
Advanced laboratory techniques. Selected experiments from many fields of modern physics. Emphasis on self-study of the phenomena, data analysis, and presentation in report form.
Prerequisite: PHYS375.
Restriction: Must be in a major within CMNS-Physics department.

PHYS407 Undergraduate Experimental Research (3 Credits)
Students develop and complete an independent, experimental research project with a professor in the Physics Department. The project should be a continuation of work done in PHYS499A. To obtain permission, students must submit a proposal describing the experimental work to be completed and this proposal must be approved by their faculty mentor, the associate chair for undergraduate education and the chair of the laboratory committee. Students must maintain a lab notebook, give an oral presentation and complete a written report on their research that includes data and error analysis.
Prerequisite: PHYS499 and PHYS375; and permission of CMNS-Physics department.
Restriction: Must be in a major within CMNS-Physics department; and senior standing.

PHYS410 Classical Mechanics (4 Credits)
Theoretical foundations of mechanics with extensive application of the methods. Various mathematical tools of theoretical physics.
Prerequisite: PHYS373.

PHYS411 Intermediate Electricity and Magnetism (4 Credits)
Foundations of electromagnetic theory, with extensive applications of the methods. Thorough treatment of wave properties of solutions of Maxwell's equations.
Prerequisite: PHYS373.

PHYS420 Principles of Modern Physics (3 Credits)
A survey of atomic and nuclear phenomena and the main trends in modern physics. Appropriate for students in engineering and other physical sciences.
Prerequisite: MATH246. And PHYS271 and PHYS270; or PHYS273.
Credit Only Granted for: PHYS371 or PHYS420.

PHYS428 Physics Capstone Research (2-4 Credits)
Individual, focused research under the guidance of a faculty member. Discussion, presentations and, if appropriate, research group projects involved. Student must submit final research paper for completion of course. Paper may also serve as thesis required for High Honors in Physics. Not intended as a general "reading course" (see PHYS499).
Restriction: Must be in a major within CMNS-Physics department; and senior standing or higher; and permission of instructor.
Repeatable to: 4 credits.

PHYS429 Atomic and Nuclear Physics Laboratory (3 Credits)
Classical experiments in atomic physics and more sophisticated experiments in current techniques in nuclear physics.
Prerequisite: PHYS405.

PHYS431 Introduction to Solid State Physics (3 Credits)
Classes of materials; introduction to basic ideal and real materials' behavior including mechanical, electrical, thermal, magnetic and optical responses of materials; importance of microstructure in behavior. One application of each property will be discussed in detail.
Prerequisite: PHYS271, PHYS270, and MATH241.
Restriction: Junior standing or higher; and must be in Engineering: Materials Science program. Cross-listed with: ENMA460.
Credit Only Granted for: ENMA460 or PHYS431.

PHYS441 Topics in Nuclear and Particle Physics (3 Credits)
A survey of concepts in particle and nuclear physics, with a topical emphasis on the impact of the Weak Interaction and the discovery of Parity Violation.
Prerequisite: PHYS401 or PHYS402.
Corequisite: PHYS402.

PHYS444 Computing Beyond the Standard Model of Particle Physics (3 Credits)
An exploration of the computing languages and techniques used to analyze large data sets in Large Hadron Collider physics with some discussion of applications in unrelated fields.
Prerequisite: PHYS371 and PHYS373; or permission of instructor.

PHYS457 Introduction to Quantum Computing (3 Credits)
An introduction to the concept of a quantum computer, including algorithms that outperform classical computation and methods for performing quantum computation reliably in the presence of noise. As this is a multidisciplinary subject, the course will cover basic concepts in theoretical computer science and physics in addition to introducing core quantum computing topics.
Prerequisite: 1 course with a minimum grade of C- from (MATH240, PHYS274); and 1 course with a minimum grade of C- from (CMSC351, PHYS373).
Restriction: Permission of CMNS-Physics department; or permission of CMNS-Computer Science department. Cross-listed with CMSC4 57.
Credit Only Granted for: PHYS457 or CMSC457. Additional infor mation: No previous background in quantum mechanics is required.

PHYS474 Computational Physics (3 Credits)
This course provides an overview of some of the most widely used methods of computational physics, including numerical integration (elementary algorithms and Monte Carlo techniques), numerical solutions of differential equations (classical equations of motion, time independent and time dependent Schrodinger equations), molecular dynamics simulations (classical many-body systems), and Monte Carlo simulations (classical models of magnetism). In addition to giving the students a basic working knowledge of these particular techniques, the goal is to make them proficient in scientific computing and programming in general, so that they will be prepared to tackle also other computational problem that they may encounter in the future.
Prerequisite: PHYS404; and PHYS373; and (PHYS165, CMSC106, or CMSC131). Or permission of instructor.

PHYS485 Electronic Circuits (4 Credits)
Theory and application to experimental physics of modern semiconductor analog and digital circuits. Emphasis on understanding passive and active elements in practical circuits. Topics span the range from simple transistor circuits to microcomputers.
Prerequisite: PHYS405.
Corequisite: PHYS374.
Restriction: Must be in a major within CMNS-Physics department.

PHYS499 Special Problems in Physics (1-16 Credits)
Research or special study. Credit according to work done.

PHYS601 Theoretical Dynamics (3 Credits)
Lagrangian and Hamiltonian mechanics, two-body central force problem, rigid body motion, small oscillations, continuous systems.
Prerequisite: PHYS410; or students who have taken courses with comparable content may contact the department.

PHYS603 Methods of Statistical Physics (3 Credits)
Foundations and applications of thermodynamics and statistical mechanics.
Credit Only Granted for: PHYS602 or PHYS603.

PHYS604 Methods of Mathematical Physics (3 Credits)
Ordinary and partial differential equations of physics, boundary value problems, Fourier series, Green's functions, complex variables and contour integration.
Prerequisite: Must have completed coursework in advanced calculus; and (PHYS411 and PHYS410). Or students who have taken courses with comparable content may contact the department.

PHYS606 Electrodynamics (4 Credits)
Classical electromagnetic theory, electro- and magnetostatics, Maxwell equations, waves and radiation, special relativity.
Prerequisite: PHYS604; or students who have taken courses with comparable content may contact the department.

PHYS615 Nonlinear Dynamics of Extended Systems (3 Credits)
Theory and applications of nonlinear dynamics of extended systems including nonlinear waves, pattern formation, turbulence, self-organized criticality and networks. Additional topics to be selected by instructor from areas of current research.
Prerequisite: PHYS601.

PHYS622 Introduction to Quantum Mechanics I (4 Credits)
First and second semesters. A study of the Schroedinger equation, matrix formulations of quantum mechanics, approximation methods, scattering theory, etc. Applications to solid state, atomic, and nuclear physics.
Prerequisite: Must have an outstanding undergraduate background in physics.

PHYS623 Introduction to Quantum Mechanics II (3 Credits)
First and second semesters. A study of the Schroedinger equation, matrix formulations of quantum mechanics, approximation methods, scattering theory etc., and applications to solid state, atomic, and nuclear physics. Continuation of PHYS 622.
Prerequisite: Must have an outstanding undergraduate background in physics.

PHYS624 Advanced Quantum Mechanics (3 Credits)
Relativistic wave equations, second quantization in many body problems and relativistic wave equations, Feynman-Dyson perturbation theory, applications to many body problems, application to quantum electrodynamics, elements of renormalization.
Prerequisite: PHYS623.

PHYS625 Non-relativistic Quantum Mechanics (3 Credits)
Non-relativistic second quantization, single particle Green's function, perturbation theory, linked cluster expansion, Feynman and Goldstone diagrams; applications to imperfect Fermi gases; superconductivity.
Prerequisite: PHYS623.

PHYS662 Intersections of Technology and Policy: Modernizing the Energy System (3 Credits)
A broad, practical introduction to the issues and assessment approaches used to evaluate technical innovation in the Energy System. Introduction to the use of Sankey Diagrams, Life Cycle Analysis, Techno-economic analysis, and Equilibrium Economic Analysis, as well as policy factors such as Energy Efficiency Standards, Vehicle Fuel Economy, Feed-in-tariffs and environmental regulations.
Restriction: Must be a graduate student in the Natural Sciences, Engineering, Public Policy, or Economics; or must be a senior in the above disciplines with a minimum cumulative GPA of 3.0.
Credit Only Granted for: PHYS662 or PLCY699B.

PHYS675 Introduction to Relativity, Gravitation and Cosmology (3 Credits)
Review of special relativity, followed by a study of the equivalence principle, curved spacetimes, and Einstein's equations. Selected applications to the solar system, stellar structure, black holes, gravitational waves, and cosmology.
Prerequisite: PHYS606 and PHYS601.

PHYS685 Research Electronics (4 Credits)
An integrated lecture and laboratory course in electronics with equal emphasis on experimental methods and results and analysis using device models and up-to-date mathematical and numerical tools. Experiments and analysis of circuits with passive and single active devices form the background for the study of operational amplifiers, digital integrated circuits and systems, and microcomputers. The general topics of impedance matching, frequency response, feedback, interfacing and the extraction of signal from noise are stressed.
Prerequisite: PHYS374 or PHYS405; or students who have taken courses with comparable content may contact the department.
Restriction: Must not have completed PHYS485.
Credit Only Granted for: PHYS485 or PHYS685.

PHYS708 Seminar in Teaching College Physics (1 Credit)

PHYS709 Seminar in General Physics (1 Credit)

PHYS715 Chaotic Dynamics (3 Credits)
Theory and applications of chaos in dynamical systems including such topics as strange attractors, Lyapanov exponents, quasiperiodicity, period doubling, intermittency, crises, fractal basin boundaries, chaotic scattering, KAM tori, and quantum chaos.
Prerequisite: PHYS601.

PHYS718 Seminar in General Physics (1 Credit)

PHYS719 Seminar in General Physics (1 Credit)

PHYS720 Quantum Technology (3 Credits)
Physical principles behind emerging quantum technologies, from quantum-limited amplifiers to atomic simulators. Examination of current and emerging platforms for quantum technologies, including neutral atom, ion trap, superconducting circuit, photonic, and spin-based approaches. Focus on hurdles for implementing quantum devices for new applications.
Prerequisite: A good grounding in electromagnetism and quantum mechanics is necessary; familiarity with density matrices and master equations will be helpful.

PHYS721 Atomic and Optical Physics I (Survey) (3 Credits)
A survey of topics involving the physics of atoms and their interaction with radiation, including atoms in external fields, lasers, atomic spectroscopy and atomic structure.
Prerequisite: PHYS623.

PHYS728 Seminar in Atomic and Molecular Physics (1 Credit)

PHYS731 Solid State Physics: Survey (3 Credits)
A variety of topics such as crystal structure, mechanical, thermal, electrical, and magnetic properties of solids, band structure, the Fermi surface, and superconductivity will be treated. Although the emphasis will be on the phenomena, the methods of quantum mechanics are freely employed in this description.

PHYS732 Introduction to Solid State Physics II (3 Credits)
Second semester of survey course in condensed matter physics including topics in semiconductors, surface physics, magnetism and superconductivity.
Prerequisite: PHYS731.

PHYS738 Seminar in Experimental Solid State Physics (1 Credit)

PHYS739 Seminar in Theoretical Solid State Physics (1 Credit)

PHYS741 Nuclear Physics: Survey (3 Credits)
An introductory survey of nuclear physics, including the following topics: properties of the two-nucleon force and the most popular phenomenological potentials; properties of nuclei including radii, shapes and charge distributions; introduction to nuclear structure models, including collective, independent particle, and shell model; basic features of radioactivity including weak interactions and alpha decay; introduction to nuclear reactions, including phenomenological optical potentials and distorted wave approximations.
Prerequisite: PHYS623 and PHYS622.

PHYS748 Seminar in Experimental Nuclear Physics (1 Credit)

PHYS749 Seminar in Theoretical Nuclear Physics (1 Credit)

PHYS752 Elementary Particle Physics II: Theory (3 Credits)
Survey of elementary particles and their properties, quantum field theory, meson theory, weak interactions, possible extensions of elementary particle theory.
Prerequisite: PHYS751 and PHYS624.

PHYS758 Seminar in Elementary Particles and Quantum Field Theory (1 Credit)

PHYS759 Seminar in Elementary Particles and Quantum Field Theory (1 Credit)

PHYS761 Plasma Physics I: Survey (3 Credits)
A detailed study of plasma physics. The first semester treats particle orbit theory, magnetohydrodynamics, plasma waves, and transport phenomena.
Prerequisite: PHYS606 and PHYS604.

PHYS762 Plasma Physics II (3 Credits)
Continuation of PHYS 761. Vlasov theory, including waves, stability, and weak turbulence, kinetic equation theories of correlations and radiative processes.
Prerequisite: PHYS761.

PHYS769 Seminar in Plasma Physics (1 Credit)

PHYS778 Seminar in Space and Cosmic Ray Physics (1 Credit)

PHYS779 Seminar in General Relativity (1 Credit)

PHYS780 Network Science Literature Survey Seminar (1 Credit)
Identify and develop a research project in Network Science. Practice communicating scientific results and concepts to individuals in their own field and in other fields to which the research is applicable.
Credit Only Granted for: PHYS780 or PHYS798T.
Formerly: PHYS798T.

PHYS798 Special Problems in Advanced Physics (1-3 Credits)
Projects or special study in advanced physics.

PHYS799 Master's Thesis Research (1-6 Credits)

PHYS808 Special Topics in General Physics (1-4 Credits)
Credit according to work done.

PHYS809 Special Topics in General Physics (1-4 Credits)
Credit according to work done.

PHYS818 Special Topics in General Physics (1-4 Credits)
Credit according to work done.

PHYS819 Special Topics in General Physics (1-4 Credits)
Credit according to work done.

PHYS828 Special Topics in Atomic and Molecular Physics (1-4 Credits)
Credit according to work done.

PHYS829 Special Topics in Quantum Mechanics and Quantum Electronics (1-4 Credits)
Credit according to work done.

PHYS838 Special Topics in Experimental Solid State Physics (1-4 Credits)
Credit according to work done.

PHYS839 Special Topics in Theoretical Solid State Physics (1-4 Credits)
Credit according to work done.

PHYS849 Special Topics in Theoretical Nuclear Physics (1-4 Credits)
Credit according to work done.

PHYS851 Advanced Quantum Field Theory (3 Credits)
Renormalization, unitarity, gauge theory, S-matrix construction.
Prerequisite: PHYS624.

PHYS858 Special Topics in Elementary Particles and Quantum Field Theory (1-4 Credits)
First semester.
Prerequisite: PHYS752 and PHYS851.

PHYS859 Special Topics in Elementary Particles and Quantum Field Theory (1-4 Credits)
Credit according to work done.

PHYS869 Special Topics in Plasma Physics (1-4 Credits)
Credit according to work done.

PHYS878 Special Topics in Space and Cosmic Ray Physics (1-4 Credits)
Credit according to work done.

PHYS879 Special Topics in General Relativity (1-4 Credits)
Credit according to work done.

PHYS888 Special Topics in Applied Physics (2 Credits)

PHYS889 Special Topics in Interdisciplinary Problems (1-4 Credits)
Credit according to work done.
Restriction: Permission of instructor.

PHYS898 Pre-Candidacy Research (1-8 Credits)

PHYS899 Doctoral Dissertation Research (1-8 Credits)