PHYS - Physics

Courses numbered 500 to 799 = *undergraduate/graduate*. (Individual courses may be limited to undergraduate students only.) Courses numbered 800 to 999 = *graduate*.

PHYS 501. Special Studies in Physics for Educators (1-3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 501A, 501B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): inservice or preservice teacher.

PHYS 501K. Nuclear Concepts (1-3).
Part of a series of courses covering basic physical concepts which provide a physical science background for teachers. Structure of atoms and the experiments that revealed this structure, quantization of matter, electric charge, and light, concepts of quantum mechanics. This course may also include further topics and applications, for example cosmic microwave background radiation or other topics of current interest.

PHYS 502. Science Investigations: Physics (3-5).
Introductory course for prospective teachers. Basic physics concepts in mechanics, heat, and electricity and magnetism developed through laboratory investigations. Emphasizes science process skills and the nature of the scientific endeavor. Prerequisite(s): MATH 111 or equivalent; inservice or preservice teacher.

PHYS 516. Advanced Physics Laboratory (2).
Experiments in classical and modern physics to stress scientific methods and experimental techniques. The experiments are open-ended projects requiring individual study. Repeatable for a total of 8 credit hours. Pre- or corequisite(s): PHYS 551.

PHYS 517. Electronics Laboratory (2).
Experiments in electronics that treat some of the applications of electronics in scientific physics research. Experiments cover the uses of transistors, op-amps, integrated and digital circuits. Prerequisite(s): PHYS 314.

PHYS 551. Topics in Modern Physics (3).
An introduction to selected areas of modern physics emphasizing the features of atomic, nuclear and solid state physics that require modifications of classical physics for their explanation. Prerequisite(s): PHYS 214 or 314, or departmental consent. Pre- or corequisite(s): MATH 344.

PHYS 555. Modern Optics (3).
Geometrical and physical optics, coherence theory and Fourier optics. Additional topics may include radiation, scattering, optical properties of solids and optical data processing. Prerequisite(s): PHYS 214 or 314 and MATH 344.

PHYS 595. Astrophysics (3).
Covers the formation, life and death of stars. Topics include: HR-diagrams, atomic and molecular spectra, radiative and convective transfer, the structure and spectra of stellar atmospheres, and stellar evolution. Prerequisite(s): PHYS 551.

PHYS 600. Individual Readings in Physics (1-3).
Arranged individual independent readings in specialized content areas under the supervision of a faculty member. Repeatable for a total of 6 credit hours for physics majors. Prerequisite(s): departmental consent.

PHYS 600B. Physics Seminar (1).
Review of current trends in physics via talks on student and faculty research. For undergraduate credit only.

PHYS 600J. Introduction to Emerging Quantum Technologies and Information Science (3).
Introduces the fundamental laws of quantum mechanics and introduces revolutionary quantum technologies and information science, including quantum communications, quantum sensing, quantum computing, and quantum information science. The course allows students to develop a conceptual understanding of quantum phenomena and identify engineering challenges of various quantum technologies. Prerequisite(s): PHYS 551.

PHYS 601. Individual Readings in Astrophysics (1-3).
Studies several topics in astronomy and astrophysics in depth. Lectures, independent readings and student projects may be assigned. Repeatable for credit up to 6 hours. Prerequisite(s): instructor's consent.

PHYS 616. Computational Physics Laboratory (2).
Provides a working knowledge of computational techniques with applications in both theoretical and experimental physics, including an introduction to the FORTRAN and C++ languages as used in physics. Pre- or corequisite(s): MATH 555.

PHYS 621. Analytical Mechanics (3).
Motion of a particle or system of particles in one or several dimensions, central forces, rotating coordinate systems, the harmonic oscillator and the Lagrangian and Hamiltonian formulation of mechanics. Prerequisite(s): PHYS 214 or 314, and MATH 344 with grades of C or better.

PHYS 631. Electricity and Magnetism (3).
Electric and magnetic field theory, direct and alternating currents and Maxwell's electromagnetic wave theory. Prerequisite(s): PHYS 214 or 314, and MATH 344 with grades of C or better.

PHYS 641. Thermophysics (3).
The laws of thermodynamics, distribution functions, Boltzmann equation, transport phenomena, fluctuations, and an introduction to statistical mechanics. Prerequisite(s): PHYS 214 or 314, and MATH 344.

PHYS 651. Quantum Mechanics I (3).
Introduction to quantum mechanics, the Schrodinger equation, elementary perturbation theory and the hydrogen atom. Prerequisite(s): PHYS 551.

PHYS 652. Quantum Mechanics II (3).
A continuation of PHYS 651 and covers time dependent perturbation theory, WKB, scattering, Bell's theorem, quantum reality, applications of quantum mechanics, and nanotechnology. Prerequisite(s): PHYS 651.

PHYS 661. Introduction to Atomic Physics (3).
Quantum mechanics is the basis of all our physical understanding of atomic and molecular spectra. This course uses quantum mechanics to understand the nature and formation of the spectra of one, two and many-electron atoms. A discussion of atomic collisions is included. Corequisite(s): PHYS 651.

PHYS 675. Nuclear/Particle Physics (3).
Theories of nuclear and particle physics, including experimental techniques and important features of current data. Summary of mesons, baryons and leptons, and their electromagnetic, strong and weak nuclear force interactions. Phenomenological descriptions of nuclear and high-energy scattering and particle production leading to the quark theory of matter and other new exotic particles. Prerequisite(s): PHYS 551.

PHYS 681. Solid State Physics (3).
A one-semester introduction to solid state physics, which explores and explains-in terms of the microscopic processes that produce them-the thermal, mechanical and electronic properties of solids. Discusses

practical applications and interdisciplinary material. Prerequisite(s): PHYS 551.

PHYS 695. Astrophysics II (3).
Continuation of PHYS 595. Covers the properties of the solar system and extra-solar planets. Other topics of modern astronomy are included such as the formation of galaxies, cosmology and the Big Bang model. Prerequisite(s): PHYS 595 or instructor's consent.

PHYS 701. Advanced Topics Physics (3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 701A, 701B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course.

PHYS 701G. Mathematical Methods in Physics (3).
This course is a continuation of PHYS 714, Theoretical Physics. It is a study of mathematical techniques applicable to physics and other sciences. Topics covered in this course include group theory, differential geometry, statistical methods, functional methods, path integrals, renormalization grouping, chaos theory, and string theory. Prerequisite(s): PHYS 714 or instructor's consent.

PHYS 702. Energy and Sustainability (3).
Cross-listed as ME 702. Introduces sustainability in a world of increasing population with more energy intensive lifestyles and diminishing resources; anthropogenic global climate change and the engineer's responsibilities; estimating our carbon footprint; surveys alternative energy sources with special emphasis on wind and solar energy; life cycle analysis (LCA) of engineered products; the electric grid; emissions from various transportation modes, and alternatives. Consists of traditional lectures, seminars by invited experts, and case studies. Meets the ME undergraduate curricular requirement for thermal/fluids elective and/or a general ME elective. *Course includes diversity content*. Pre- or corequisite(s): ME 522 or PHYS 551; or instructor's consent.

PHYS 714. Theoretical Physics (3).
A study of mathematical techniques applicable to physics and other sciences. Instructor selects topics, such as power series, infinite products, asymptotic expansions, WKB method, contour integration and residue methods, integral transforms, Hilbert spaces, special functions and integral equations. Prerequisite(s): MATH 555 or instructor's consent.

PHYS 730. Computational Methods for Physics (3).
Introduces students to numerical methods for solving physical problems. Topics include root-finding, interpolation, differentiation, integration and differential equations. Students learn to write computer programs to solve these problems and to interpret and visualize their results. The course is suitable for students who want to pursue research in physics or related fields, as well as those who want to develop skills in scientific computing. Students are expected to have a background in calculus, differential equations and linear algebra. Some experience using a programming language is helpful but not required. Prerequisite(s): PHYS 551, MATH 344, MATH 511, and MATH 555 or departmental consent.

PHYS 761. Environmental Physics (3).
Covers the application of physics to the environment, including the production and use of energy, the transport of pollutants, and the study of noise. Topics include basic thermodynamics with applications to fossil fuels, hydroelectric, wind, geothermal and solar energies, plus effects on global warming, pollution and climate. Prerequisite(s): PHYS 313-314 and MATH 242, or EEPS 721, or instructor's consent.

PHYS 795. Earth and Space Physics (3).
An introduction to the geosciences and astrophysics of the solar system. Topics include the surface, interior and atmospheres of the planets with a comparative planetology approach, and the sun-planet system including solar physics and the effect of the sun on the earth's environment and geologic history. Prerequisite(s): PHYS 313-314 and MATH 242, or EEPS 721, or instructor's consent.

PHYS 800. Individual Readings (1-3).
Arranged individual readings in specialized content areas under the supervision of a faculty member. Repeatable for credit up to 3 credit hours. Prerequisite(s): 30 credit hours of physics and departmental consent.

PHYS 801. Selected Topics (2-3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 801A, 801B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): departmental consent.

PHYS 801J. Introduction to Emerging Quantum Technologies and Information Science (3).
Introduces the fundamental laws of quantum mechanics and introduces revolutionary quantum technologies and information science, including quantum communications, quantum sensing, quantum computing and quantum information science. The course allows students to develop a conceptual understanding of quantum phenomena and identify engineering challenges of various quantum technologies. Prerequisite(s): PHYS 651 or departmental consent.

PHYS 807. Seminar (1).
Review of current periodicals; reports on student and faculty research. Repeatable for credit up to 2 hours. Prerequisite(s): 20 hours of physics.

PHYS 809. Research (1-3).
Pursue research directed by a faculty member. Repeatable for credit.

PHYS 811. Quantum Mechanics (3).
The Schrodinger and Heisenberg formulations of quantum mechanics. Applications include rectangular potentials, central forces, and the harmonic oscillator. Also includes spin, time independent and time dependent perturbation theory. Prerequisite(s): PHYS 621, 651 or departmental consent and MATH 555.

PHYS 812. Advanced Quantum Mechanics (3).
Applications of quantum mechanics. Topics which may be included are the WKB approximation, scattering, N-body problem, second quantization and relativistic quantum mechanics. Prerequisite(s): PHYS 811.

PHYS 816. Methods in Experimental Physics (3).
Students perform experiments in modern physics and an analysis of the results including assessment of errors. Experimental and statistical techniques to assess statistical and systematic sources of error are presented. Prerequisite(s): PHYS 516, PHYS 517 or their equivalents.

PHYS 821. Classical Mechanics (3).
The Lagrangian, Hamiltonian and Hamilton-Jacobi methods of mechanics and an introduction to variational calculus. Applications selected from central forces, rigid bodies, relativity, small oscillations and continuous media. Prerequisite(s): PHYS 621, MATH 555.

PHYS 831. Classical Electricity and Magnetism (3).
Maxwell's equations with application to static electricity and magnetism. Also may include electromagnetic fields, vector potentials, Greens functions, relativity, optics and magnetohydrodynamics. Prerequisite(s): PHYS 631, MATH 555.

PHYS 845. Space Science Foundations (3).
Cross-listed as EEPS 845. Presents an understanding of the extreme special conditions encountered in space. Introduces the heliopause formed by the protective bubble of the sun, which starts as a solar wind, and how spacecrafts or planets survive this special space environment. Studies ideas on propulsion, launch trajectories and orbital principles. Introduces spacecraft systems, communications, navigation and design principles necessary to successfully transverse space. Presents astrobiology and the special space environment that creates especially difficult hardships to which life in space must adapt in order to survive. Introduces space ethics and laws set forth by international treaties. Prerequisite(s): PHYS 795 or GEOL 795.

PHYS 851. Plasma Physics (3).
Introduces the basic physics process associated with plasma, which permeates all of space and space environments. Studies both the fluid and particle nature of the problem and derives a description using wave phenomena and elementary particle drift. Describes applications of the theory to real space environments along with special examples between planets and the plasma, space-craft and the plasma, as well as explains the solar origin of the plasma. Other advanced topics in plasma physics such as fusion or magneto hydrodynamics is covered as student interest and time permits. Prerequisite(s): PHYS 631 or ECE 463.

PHYS 855. Radiation Physics (3).
Covers basic nuclear processes in radioactive sources and the radiation effects on matter, their detection and simulations. Reviews the basic characteristics of all types of common radiation and detectors, and specific classes of detectors such as scintillation, ionization and semiconductors. Emphasizes the physical processes from generation and the effects on all types of matter such as tissue, space-craft parts and detectors. The basic ideas behind signal processing and state-of-the-art data analysis techniques. Prerequisite(s): PHYS 551 and (PHYS 631 or ECE 463).

PHYS 871. Statistical Mechanics (3).
An introduction to the basic concepts and methods of statistical mechanics with applications to simple physical systems. Prerequisite(s): MATH 555, PHYS 621.

PHYS 876. Elementary Particles & Fields (3).
A survey of nuclear, elementary particle and astro-particle physics topics in the mathematical framework of the Standard Model and its experimental verification. Students may benefit from taking PHYS 816 prior to this course, but it is not required. Prerequisite(s): PHYS 811 or departmental consent.

PHYS 881. Solid State Physics (3).
A second course in solid state physics for students who have had an introduction to the subject. Transport, dielectric and optical properties, magnetic properties, superconductivity and applications to semi-conductor devices. Prerequisite(s): MATH 555, PHYS 651, 681, or departmental consent.

PHYS 895. Advanced Astrophysics (3).
Covers topics in astrophysics in relation to stellar structure, atmospheres and stellar evolution. Advanced topics in galactic dynamics, formation and cosmology may be included. Prerequisite(s): PHYS 595 or instructor's consent.

PHYS 909. Research in Physics (1-9).
Pursue research towards PhD directed by a faculty member. Repeatable for credit.

PHYS 983. Advanced Independent Study in Physics (1-3).
Arranged individual directed study in an area of physics. Repeatable for credit with departmental consent. Prerequisite(s): instructor's consent.

PHYS 987. PhD Dissertation (1-9).
Student-driven research experience to address a specific research question. Potential topics should be formulated by the student and discussed with their advisor. Repeatable for credit. Prerequisite(s): must have passed the PhD preliminary exam in physics.