

PHY 099/Orientation to Physics

0 course unit

(fall, every year)

Required as an entry course of all first-year and transfer students enrolled in majors offered by the Department of Physics. Topics covered include degree requirements, general information about the college and services offered, career opportunities in physics, academic standards and integrity, study habits, time management, and resume development. General and personal advisement relative to pursuit of the major and the degree is also included.

PHY 103/Physical, Earth, and Space Sciences

1 course unit

(with laboratory)

(every semester)

Restricted to students in Elementary Education, Early Childhood Education, Education of the Deaf and Hard of Hearing, and Special Education.

This course introduces various topics from physical, earth, and/or space sciences, such as motion, Newton's laws, energy, momentum, thermal energy, fluids, light, electromagnetic forces and fields, the Earth, the Solar System and the universe. Algebra-based equations, graphs, and scientific notations are used. Concepts are reinforced through laboratory experiments and problem-solving. This course is designed for elementary-level education majors to help them meet New Jersey state standards.

PHY 120/Introduction to Geology

1 course unit

(with laboratory)

(every semester)

Geological concepts, principles, and processes as they relate to the relationship between people and their environment are emphasized. Topics include: minerals and rocks, components of the hydrologic cycle, dynamic earth processes, and regional studies.

PHY 121/Principles of Physics

1 course unit

(with laboratory)

(fall, every year)

Not for science or mathematics majors

Centered around the basic laws of physics, emphasis is on a conceptual understanding of the natural world regarding concepts which comprise it and their connections and relationships to each other. Topics include force, motion, momentum, energy and gravitation. Laboratory emphasis is given through hands-on activities.

PHY 161/Introduction to Astronomy

1 course unit

(with laboratory)

(every semester)

A study of the knowledge gained in our investigation of the universe from an historical perspective. Topics included are the Earth and its motions; time and the calendar, the seasons; the properties, origin, and evolution of the solar system, and stars and stellar systems, including galaxies; and cosmology. Laboratory sessions will involve an investigation of observable celestial phenomena, including celestial coordinates, the diurnal motions of the stars, the orbital motions of the planets, the phases of the Moon, and eclipses, through the use of interactive computer software, and the TCNJ planetarium and observatory facilities. Some nighttime observing is included.

PHY 171/Introduction to Meteorology

1 course unit

(with laboratory)

(spring, every year)

Basic weather processes and forecasting are emphasized. Topics include: the Earth-Sun System, heat balance, moisture and precipitation, air masses and fronts, storm systems, ocean circulation, climate, atmospheric optics, air pollution and satellite imagery.

PHY 201/General Physics I

1 course unit

(with laboratory)
(every semester)

Pre- or Corequisite: MAT 125 or MAT 127

Calculus-based introductory physics, first course of a two semester sequence. Topics covered include motion, Newton's Laws, conservation principles, rotational motion and oscillatory behavior. Problem solving is an integral part of the course. Conceptual understanding is reinforced using interactive computer-based techniques, demonstrations, and laboratory experiences.

PHY 202/General Physics II

1 course unit

(with laboratory)
(every semester)

Prerequisites: PHY 201 and MAT 127

Usual Pre- or Corequisite: MAT 128

Second part of two semester calculus-based introductory course. Topics include: electricity and magnetism, optics, and topics in modern physics. Problem solving is an integral part of the course. Conceptual understanding is reinforced using interactive computer-based techniques, demonstrations, and laboratory experiences.

PHY 220/Advanced Geology

1 course unit

(with laboratory)
(spring, odd-numbered years)

Prerequisites: PHY 120 (recommended) or PHY 201 or permission of instructor

The goal of this course is to present a modern, inquiry-based introduction to plate tectonics, earthquakes, and volcanoes. Topics include seismic wave interpretation, fault mechanics, earthquake prediction, volcanic hazards, volcanism and climate change, and more. This course is writing intensive and students will write two formal laboratory reports and a term paper from a topic of their choosing related to the course material.

PHY 261/Advanced General Astronomy

1 course unit

(fall, odd-numbered years)

Prerequisites: MAT 128 and WRI 102 or waiver

This course is a study of the knowledge gained from the investigation of the stellar universe, including the Sun and its satellites. Topics include the properties, structure, and evolution of stars, star clusters, galaxies, and cosmology. An emphasis will be placed on the methodology employed by astronomers and astrophysicists to investigate the stellar world. The methods used for the analysis of observational data are facilitated by the use of interactive computer software in the astronomy lab. The course involves some simple programming. Use will also be made of the planetarium and facilities of the TCNJ observatories. This is a mid-level writing intensive course.

PHY 299/Research Fundamentals Seminar

0.25 course unit

(spring every year; may be taken more than once)

Required for Physics/Secondary Education majors; suggested for all Physics majors

This seminar course is designed to contextualize current research topics in physics and provide exposure to the fundamental techniques required to pursue scholarly research in the physical sciences. Students will attend departmental and school colloquia and examine primary academic literature to synthesize speakers' scholarly records with the attended talks. Students will also design and propose a small-scale research project that could lead to an independent research experience in subsequent semesters.

PHY 306/Mathematical Physics

1 course unit

(fall, every year)

Prerequisites: PHY 202 and MAT 128

A study of the mathematical methods used by experimental and theoretical physicists to solve a variety of physical problems. Topics include complex numbers, partial derivatives, multiple integrals, curvilinear coordinates, matrix algebra, vector and tensor calculus, Fourier analysis, ordinary and partial differential equations, boundary value problems, special functions and advanced numerical techniques. Mathematica and/or Fortran will be used for both algebraic and numerical computations.

PHY 311/Analog and Digital Electronics

1 course unit

(with laboratory)

(fall, even-numbered years)

Prerequisite: PHY 202

Fundamentals of analog and digital circuits. Topics in analog electronics include circuit analysis, alternating current circuits, transient signals, frequency filters, diodes, transistors, and op-amp circuits. Topics in digital electronics include logical networks, flip-flops, analog-to-digital-to-analog converters, microcomputers, and transducer applications. Laboratory activities are hands-on with intensive use of oscilloscopes, frequency generators, analog components, transducers and robots. A robotics competition is a capstone experience for this course.

PHY 316/Biomedical Physics

1 course unit

(spring, even-numbered years)

Prerequisite: PHY 202 and WRI 102 or waiver

A study of physics that has medical and biological applications. Intended for physics and other majors who are adept at problem solving and are often interested not only in careers in physics, but also in medicine, biology, biophysics, or medical physics. Topics include electrical properties of nerve and muscle cells, conduction system of the heart, theory of electrocardiography, scattering, absorption, and emission of radiation, thermodynamics of living systems, medical use of x-rays, computed tomography (CT), PET scanners, nuclear physics and nuclear medicine, and magnetic resonant imaging (MRI).

PHY 321/Modern Physics

1 course unit

(with laboratory)

(fall, every year)

Prerequisite: PHY 202, MAT 128

Study of modern physics concepts pertaining to the microscopic universe, thereby giving the student a better understanding of the macroscopic universe. Fundamental concepts of modern physics are covered, including topics in the special theory of relativity, wave-particle duality, quantization of energy, Schrodinger equation, potential wells, and atomic physics. The experimental basis for modern physics is also discussed.

PHY 345 / Physics of Clouds and Climate

1 course unit

(spring, even-numbered years)

Prerequisite: PHY 202 or PHY 201 and MAT 128

This is a course focused on the study of the physical components and processes of Earth's atmosphere, with special focus on the intertwined physics of clouds and climate change. The course takes an interactive approach to understanding clouds and radiation in the atmosphere, including collaborative problem solving, topical literature review and writing, tutorials on state-of-the-art weather forecasting software, 3D visualizations, and several field exercises. The course satisfies the mid-level writing assignment.

PHY 356 /Thermal Physics

1 course unit

(spring, every year)

Prerequisites: PHY 202, MAT 128 and MAT 326 (recommended)

A study of the interrelationships between temperature, thermal energy, work, and entropy and the interactions of physical systems. The main topics covered are thermodynamic coordinates, equations of state, the laws of thermodynamics, adiabatic processes, heat engines, kinetic theory and statistical thermodynamics.

PHY 361/Galactic and Extragalactic Astronomy

1 course unit

(fall, even-numbered years)

Prerequisites: PHY 202 (or PHY 161 and permission of instructor) and WRI 102 or waiver.

Study of the composition, structure and kinematics of our home Galaxy, the Milky Way, and the corresponding properties of other galaxies. Interplay between stars and interstellar medium; spiral, elliptical and irregular galaxies; galaxy formation and evolution; active galactic nuclei; the cosmic distance ladder. This is a mid-level writing intensive course: students will write multiple drafts of review papers covering specific topics within this broad field.

**PHY 370/Topics in Physics
(occasionally)**

1 course unit

Topics such as atmospheric physics, computational fluid dynamics or galactic and extragalactic astrophysics will be covered.

**PHY 371/Topics in Physics (Writing Intensive)
(occasionally)**

1 course unit

Topics such as atmospheric physics, computational fluid dynamics or galactic and extragalactic astrophysics will be covered within the framework of a mid-level writing intensive experience.

PHY 390/Methods of Teaching Science

1 course unit

(fall, every year)

Prerequisite: WRI 102 or waiver

Research and presentations of topics relating to issues in modern science education with special emphasis on the first-year teacher. Topics include evolution of scientific concepts, presentations and evaluations of demonstrations, classroom management and techniques with an emphasis on preparation for Student Teaching.

PHY 391/Independent Study in Physics

variable course units

(every semester)

Prerequisites: Junior/senior standing and permission of faculty mentor and department chair

A student, in collaboration with a faculty member, will study an advanced topic in physics or a related field.

PHY 393/Independent Research I

variable course units

(every semester)

Prerequisite: Junior/senior standing in Physics with a minimum 2.5 GPA and approval of supervising faculty member and department chair

Independent study in a selected area of physics, geology, meteorology or astronomy through the use of scientific journals, source books and experimentation or computation. This course is normally appropriate for students of sophomore or junior standing, with a GPA of 2.5 or higher. A poster paper or oral presentation describing the research results are given to the department at the end of the semester.

PHY 399/Physics Research Internship

1 course unit

(every fall; may be repeated once for credit)

The course provides an opportunity for students to receive TCNJ credits for pertinent internships or research experiences at off-campus institutions through an extension of that work with a TCNJ

Faculty Mentor (FM). To register, the student needs to obtain prior approval from the FM and Chair of the Physics Department. In the course, the student is expected to actively engage in literature search and to work closely with the FM to synthesize the work done during the internship, to produce and deliver an oral or poster presentation, and to write a high quality paper based on the research. This is a writing intensive course.

PHY 401/Classical Mechanics **1 course unit**

(spring, every year)

Prerequisites: PHY 306 or MAT 229 and PHY 321 Recommended

Co-requisite: MAT 326

Newtonian mechanics is studied rigorously using advanced mathematical and numerical techniques. Topics treated include kinematics, dynamics, harmonic oscillations, central forces, many particle systems, rigid bodies, Lagrangeans, and Hamiltonians. Scientific programming is used extensively in problem solving.

PHY 411/Electromagnetic Waves and Optics **1 course unit**

(with laboratory)

(fall, odd-numbered years)

Prerequisites: PHY 306 or MAT 229

Properties of electromagnetic waves are studied, with a focus on visible light. Topics include wave motion, interaction of electromagnetic waves with matter, geometrical and physical optics, polarization, optical instruments, holography, laser physics, and quantum optics at an intermediate level. Laboratory work involves designing experiments to verify physical models and use of photonics research equipment. The course provides the foundation for imaging, laser physics and optical spectroscopy techniques.

PHY 413/General Relativity and Cosmology **1 course unit**

(fall, even-numbered years)

Prerequisites: PHY 306 or MAT 229

Modern formulation of Einstein's General Relativity. This course emphasizes field equations and the solutions applicable to astrophysical problems, including topics relating to black holes, gravitational lensing, and gravitational radiation. Additional topics include the dynamics of the universe--Standard Cosmology. The course provides a strong background suitable for higher studies in theoretical physics, astronomy, or mathematics.

PHY 421/Electromagnetic Theory I **1 course unit**

(fall, every year)

Prerequisites: PHY 306 or MAT 229 and *Recommended pre/co-requisite* MAT 326, or permission of instructor

A study of the theory and laws of classical electromagnetism and development of the basic concepts and equations of electrostatics. Topics to be addressed are: applications of Coulomb's Law, nature of the electric field, applications of Gauss' Law, potential, theory, dielectric theory, conductors in electromagnetic fields, energy of the electromagnetic field, and special methods in electrostatics.

PHY 422/Electromagnetic Theory II **1 course unit**

(spring, even-numbered years)

Prerequisite: PHY 421

A continuation of PHY 421 dealing with electric currents and magnetic fields, Biot-Savart Law, Faraday Induction Law, magnetic potential, Maxwell's Equations, and electromagnetic waves.

PHY 426/Particle and Nuclear Physics **1 course unit**

(occasionally)

Prerequisites: PHY 321, PHY 431 or permission of instructor

Fundamental concepts and applications of Particle and Nuclear Physics will be discussed such as the standard model, the shell model of nuclei, accelerators, radioactivity, nuclear medicine,

nuclear reactors and nuclear waste. Seminars, problem solving and computer projects are integral parts of the course.

PHY 431/ Quantum Mechanics **1 course unit**

(fall, every year)

Prerequisites: PHY 306, and 321 or permission of instructor

Fundamental concepts of quantum mechanics and applications to problems in modern physics are examined using the Schrödinger and matrix approaches. Topics include: mathematical tools of quantum mechanics, postulates of quantum mechanics, time evolution of the system's state, conservation laws, quantum mechanics in one and three dimensions, orbital and spin angular momenta and approximation methods. Problem solving and computer projects are integral parts of the course.

PHY 436/Condensed Matter **1 course unit**

(spring, odd-numbered years)

Prerequisites: PHY 306 or MAT 229 and PHY 321

Fundamental concepts of condensed matter and applications to problems in current theoretical and applied physics are presented. Topics covered include crystal structure, lattice vibrations, phonons, thermal properties of matter, free electron theory of metals, band theory, semiconductors, superconductors, optical properties of solids and magnetism. Problem solving and computer projects are integral parts of the course.

PHY 451/Advanced Experimental Physics **1 course unit**

(spring, 2012; afterward, spring, odd-numbered years)

Prerequisites: PHY 306, PHY 321 or permission of instructor, WRI 102 or waiver

Students take part in experiments or projects of high caliber comparable to actual research in the areas of expertise of participating faculty members. The course consists of 1 lecture hour and 3 hours of laboratory per week. The lecture hour will be used to acquaint the students with the theory and principles of physics fundamental to the experiments to be done and the methods to apply in analyzing archival data. Individual experiments typically take more than one week to complete. Students will be expected to devote time every week to compiling the results into a formal report equivalent to a paper to be submitted for publication in a journal. Emphasis will be given to in-depth writing and literature searches. This is an upper-level writing intensive course that can serve as a capstone course. Papers may be presented and discussed at departmental colloquia.

PHY 466/Astrophysics **1 course unit**

(spring, odd-numbered years)

Prerequisites: PHY 321 or permission of instructor

The study of the knowledge gained from the investigation of the stellar universe and the physics applied thereto. This includes atomic structure, radiative process, spectroscopy, thermostatics of excitation and ionization equilibria, photometry, radiation transport, absorption, and scattering theory. Also covered are the principles of stellar structure and evolution; the structure and evolution of star clusters, galaxies and cosmology. An emphasis will be placed on the methodology employed by astrophysicists to investigate the stellar world.

PHY 478/Special Topics in Condensed Matter **1 course unit**

(occasionally)

Topics such as the mechanical, optical and electrical properties of solid materials will be covered.

PHY 490/Student Teaching: Physics **2 course units**

(every semester)

Prerequisites: PHY 390 and meeting all criteria for admission to student teaching, including completion of all required courses and Physics requirements.

Student teaching during one semester of the senior year with an approved teacher in a public school under supervision of the cooperating teacher and college supervisors.

PHY 493/Independent Research II

variable course units

(every semester)

Prerequisites: Senior standing in physics and permission of faculty mentor and department chair
This writing-intensive, capstone experience will consist of the student, in collaboration with a faculty mentor, studying an advanced research topic. A scientific talk and written research-quality paper will be submitted to the department at the end of the semester.