

Physics

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The objectives of the department are to develop the student's comprehension of the basic principles of physics, to instill a sense of inquiry in the student, to develop an appreciation of the role of physics in our attempt to understand the universe, and to develop an understanding of its power to deal with problems related to technology and the environment.

The physics major can, by proper choice of electives, prepare for graduate work in physics, astronomy, geophysics, environmental science, or professional schools such as medicine or law. The student may also choose to work in industry, public service, or teaching. The program for prospective teachers will prepare graduates to teach various courses ranging from high school physics to science in the junior high and middle schools, depending on the courses elected. Therefore, it is strongly recommended that the student elect those courses which will satisfy the demands of his or her chosen profession.

The computational physics track combines physics, computer science, and mathematics. A graduate of this program will have an understanding of physics and, in addition, will be able to apply computer knowledge to the solution of various technical problems.

Program Entrance, Retention, and Exit Standards

Every major program at the College has set standards for allowing students to remain in that program, to transfer within the College from one program to another, and to graduate from a program. The following are the standards for physics programs. Minimum grades are noted in parentheses.

- Retention in the program is based on the following performance standards in these "critical content courses": PHY 201 (C-), PHY 202 (C-), PHY 321 (C-).
- Transfer into the program from another program within the College is based upon the following performance standards in this "foundation course": PHY 201 (C-).
- Graduation requires a GPA of 2.0 in courses for the program and earning a minimum grade of C- in the following courses: PHY 201 (C-), PHY 202 (C-), PHY 321 (C-).

Physics Major (PHYA)—Physics Liberal Arts Track

Physics Major Required Courses (14 course units)

PHY 099/Orientation to Physics	0 course unit
PHY 201, 202/General Physics I, II	2 course units
PHY 306/Mathematical Physics	1 course unit
PHY 311/Electric Circuits and Electronics	1 course unit
PHY 321/Modern Physics	1 course unit
PHY 401/Classical Mechanics	1 course unit
PHY 411/Optics and Wave Motion	1 course unit
PHY 416/Thermodynamics	1 course unit
PHY 421, 422/Electromagnetic Theory I, II	2 course units
PHY 431/Introduction to Quantum Mechanics	1 course unit
PHY 451/Advanced Physics Laboratory	1 course unit
Two physics options (see below)	2 course units

Physics Major Option Courses (select two)

PHY 413/An Introduction to General Relativity	1 course unit
PHY 436/Solid State Physics	1 course unit
PHY 466/Introductory Astrophysics	1 course unit

Physics required correlates (six course units)

CHE 201, 202/General Chemistry I,II	2 course units
CSC 215/Computer Science I	1 course unit
MAT 127, 128/Calculus A,B	2 course units
MAT 326/Differential Equations	1 course unit

Suggested First-Year Sequence (PHYA)**Fall Semester**

FSP First Seminar	1 course unit
PHY 099/Orientation to Physics	0 course unit
PHY 201 General Physics I	1 course unit
MAT 127/Calculus A	1 course unit
Liberal Learning	1 course unit

Spring Semester

PHY 202/General Physics II	1 course unit
CSC 215/Computer Science I	1 course unit
MAT 128/Calculus B	1 course unit
WRI 102/Academic Writing* (if not exempted)	1 course unit

**It is recommended that students exempted from this course take another liberal learning course.*

Physics Major (PHYC)—Computational Physics Track**Physics Major Required Core Courses (five course units)**

PHY 099/Orientation to Physics	0 course unit
PHY 201, 202/General Physics I, II	2 course units
PHY 306/Mathematical Physics	1 course unit
PHY 311/Electrical Circuits and Electronics	1 course unit
PHY 321/Modern Physics	1 course unit

Physics Options (select six course units)

PHY 316/Intermediate Physics for Medicine and Biology	1 course unit
PHY 393/Independent Research	1 course unit
PHY 401/Classical Mechanics	1 course unit
PHY 411/Optics and Wave Motion	1 course unit
PHY 413/An Introduction to General Relativity	1 course unit
PHY 416/Thermodynamics	1 course unit
PHY 421/Electromagnetic Theory I	1 course unit
PHY 422/Electromagnetic Theory II	1 course unit
PHY 426/Particle and Nuclear Physics	1 course unit
PHY 431/Introduction to Quantum Mechanics	1 course unit
PHY 436/Solid State Physics	1 course unit
PHY 451/Advanced Physics Laboratory	1 course unit

PHY 493/Independent Research II	1 course unit
PHY 466/Introduction to Astrophysics	1 course unit

Computation Core (six course units)

MAT 127, 128/Calculus A,B	2 course units
CSC 220/Computational Problem Solving	1 course unit
CSC 230/Computer Science II	1 course unit
CSC 310/Discrete Structures	1 course unit
CSC 340/Programming in the Large	1 course unit

Computation Options (three course units—by advisement)

Suggested First-Year Sequence (PHYC)

Fall Semester

FSP First Seminar	1 course unit
PHY 099/Orientation to Physics	0 course unit
PHY 201/General Physics I	1 course unit
MAT 127/Calculus A	1 course unit
Liberal Learning	1 course unit

Spring Semester

PHY 202/General Physics II	1 course unit
CSC 215/Computer Science I	1 course unit
MAT 128/Calculus B	1 course unit
WRI 102/Academic Writing* (if not exempted)	1 course unit

**It is recommended that students exempted from this course take another liberal learning course.*

Physics Major (PHYT)—Physics Teacher Preparation Track

Candidates for a teacher-education certificate must have a 2.75 cumulative grade point average to successfully complete their teacher education program. They also must meet the state hygiene/physiology requirement, and pass the appropriate Praxis examination before the New Jersey State Department of Education will issue the appropriate certificate. Teacher-education candidates will receive a “certificate of eligibility with advanced standing” which requires a candidate to be provisionally certified for his or her first year of teaching. After one year of successful teaching, the candidate is eligible for a permanent certificate. The teacher-education candidate also will have to pay a fee during his or her first year of teaching.

An overview of the entire secondary-level teacher preparation sequence for students matriculating at the College beginning in 2003 can be found in the section of this bulletin for the Department of Education Administration and Secondary Education. Course descriptions for discipline-specific methods courses and student teaching in physics will be available (pending approval) in January 2005.

Required Major Courses (10 course units)

AST 161/Introduction to Astronomy	1 course unit
GEO 120/Introduction to Geology	1 course unit
MET 171/Introduction Meteorology	1 course unit
PHY 099/Orientation to Physics	0 course unit

PHY 201, 202/General Physics I, II	2 course units
PHY 311/Electric Circuits and Electronics	1 course unit
PHY 321/Modern Physics	1 course unit
PHY 390/Methods of Teaching Science	1 course unit
Two physics options (see below)	2 course units

Physics Options

PHY 306/Mathematical Physics	1 course unit
PHY 316/Intermediate Physics for Medicine and Biology	1 course unit
PHY 401/Classical Mechanics	1 course unit
PHY 411/Optics and Waves	1 course unit
PHY 413/An Introduction to General Relativity	1 course unit
PHY 416/Thermodynamics	1 course unit
PHY 421/Electromagnetic Theory I	1 course unit
PHY 422/Electromagnetic Theory II	1 course unit
PHY 426/Particle and Nuclear	1 course unit
PHY 431/Introduction to Quantum Mechanics	1 course unit
PHY 436/Solid State Physics	1 course unit
PHY 451/Advanced Physics Laboratory	1 course unit
PHY 466/Introductory Astrophysics	1 course unit
PHY 493/Independent Research II	1 course unit

Required Correlates (seven course units)

CHE 201, 202/General Chemistry I, II	2 course units
CHE Chemistry options (see below)	2 course units
CSC 215/Computer Science I	1 course unit
MAT 127, 128/Calculus A,B	2 course units

Chemistry Options

CHE 353, 354/Organic Chemistry I, II
CHE 371/Physical Chemistry
CHE 340/History of Chemistry and Physics
CHE 310/Analytical Chemistry

Suggested First-Year Sequence (PHYT)

Fall Semester

FSP First Seminar	1 course unit
PHY 099/Orientation to Physics	0 course unit
PHY 201/General Physics I	1 course unit
MAT 127/Calculus A	1 course unit
Liberal Learning	1 course unit

Spring Semester

PHY 202/General Physics II	1 course unit
CSC 215/Computer Science I	1 course unit
MAT 128/Calculus B	1 course unit
WRI 102/Academic Writing* (if not exempted)	1 course unit

**It is recommended that students exempted from this course take another liberal learning course.*

Physics Major PHYG—Earth Science Track

Required Courses (11 course units)

AST 161/Introduction to Astronomy	1 course unit
GEO 120/Introduction to Geology	1 course unit
GEO 220/Advanced Geology	1 course unit
MET 171/Introduction to Meteorology	1 course unit
PHY 099/Orientation to Physics	0 course unit
PHY 201, 202/General Physics I,II	2 course units
PHY 311/Electric Circuits and Electronics	1 course unit
PHY 321/Modern Physics	1 course unit
Three physics options (see below)	3 course units

Physics Options

AST 261/Astronomy II	1 course unit
PHY 306/Mathematical Physics	1 course unit
PHY 316/Intermediate Physics for Medicine and Biology	1 course unit
PHY 393/Independent Research I	1 course unit
PHY 401/Classical Mechanics	1 course unit
PHY 411/Optics and Waves	1 course unit
PHY 413/An Introduction to General Relativity	1 course unit
PHY 416/Thermodynamics	1 course unit
PHY 421/Electromagnetic Theory I	1 course unit
PHY 422/Electromagnetic Theory II	1 course unit
PHY 426/Particle and Nuclear	1 course unit
PHY 431/Introduction to Quantum Mechanics	1 course unit
PHY 451/Advanced Physics Laboratory	1 course unit
PHY 466/Introductory Astrophysics	1 course unit
PHY 493/Independent Research II	1 course unit

Required Correlates (five course units)

CHE 201, 202/General Chemistry I, II	2 course units
CSC 215/Computer Science I	1 course unit
MAT 127, 128/Calculus A, B	2 course units

Suggested First-Year Sequence (PHYG)

FSP First Seminar	1 course unit
PHY 099/Orientation to Physics	0 course unit
PHY 201, 202/General Physics I, II	2 course units
CSC 215/Computer Science I	1 course unit
MAT 127, 128/Calculus A, B	2 course units
WRI 102/Academic Writing (if not exempted) *	1 course unit
Liberal Learning	1 course unit

**It is recommended that students exempted from this course take another liberal learning course.*

Elementary Education-M/S/T (ELST) and Early Childhood Education-M/S/T (ECST) with a Physics Specialization

This interdisciplinary major integrates formal study in mathematics, science, and technology and consists of a common “core” with a “specialization” in one of the M/S/T disciplines. Students electing a physics specialization will complete 10 course units of common core requirements including MAT 127, 128/Calculus A, B, PHY 201, 202/General Physics I, II, one approved non-physics science course, TST 171/Fundamentals of Technology, TST 181/Structures and Mechanisms, TED 460/Integrated M/S/T for the Child/Adolescent Learner, and two M/S/T approved electives. The physics specialization consists of a minimum of three additional course units including PHY 321/Modern Physics, and PHYS 306/Mathematical Physics and an advanced physics elective at the 400 level or above. See the M/S/T academic program coordinator for general advisement.

Physics Minor

A minor in physics requires a total of five course units. The required courses are PHY 201, 202/General Physics I and II, PHY 321/Modern Physics, and PHYS 306/Mathematical Physics. One advanced physics course (400 level or higher) must be added with the approval of the department chair.

PHY 201, 202/General Physics I, II

PHY 306/Mathematical Physics

PHY 321/Modern Physics

One advanced course elected at the 400 level with the prior approval of the physics department chair.

PHY 099/Orientation to Physics

0 course unit

(every fall)

Prerequisite: Completion of College Basic Skills requirements

Required as an entry course of all freshmen 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 120/Introduction to Geology

1 course unit

(with laboratory)

(every semester)

Same as GEO 120

Prerequisite: Completion of College Basic Skills requirements

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 I

1 course unit

(with laboratory)

(every fall)

Prerequisite: Completion of College Basic Skills requirements

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 122/Principles of Physics II **1 course unit**
(with laboratory)
(every spring)

Not for science or mathematics majors.

Physical laws and concepts which clarify understanding of the physical environment. Stress on unity of physical ideas. Topics include wave motion, electric charges and fields, magnetism, light, and atomic and nuclear physics.

PHY 161/Introduction to Astronomy **1 course unit**
(with laboratory)
(every semester)

Same as AST 161

Prerequisite: Completion of College Basic Skills requirements

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 properties, origin, and evolution of (1) the solar system, and (2) stars and stellar systems, including galaxies; and cosmology. Laboratory sessions will involve an investigation of observable celestial phenomena, including 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)
(fall semester)

Same as MET 171

Prerequisite: Completion of College Basic Skills requirements

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 127

Calculus-based introductory physics, first course of a two semester sequence designed for science and mathematics majors. 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)

Prerequisite: PHY 201

Pre- or Corequisite: MAT 128

Second part of two-semester Calculus-based introductory course in electricity and magnetism, optics, and topics in modern physics. The important laws of physics in these areas and problem solving are emphasized. Problem solving is an integral part of the course. Conceptual understanding is reinforced using interactive computer-based techniques, demonstrations, and laboratory experiences.

PHY 306/Mathematical Physics **1 course unit**

(annually—spring)

Prerequisites: PHY 202 and CSC 215, or permission of instructor

Study of the methods used by theoretical physicists in solving problems, such as matrix algebra, vector calculus, and orthogonal functions. Emphasizes the major areas of classical physics such as mechanics, thermodynamics, and electromagnetism.

PHY 311/Electrical Circuits and Electronics **1 course unit**

(with laboratory)

(alternate years)

Prerequisite: PHY 202

Fundamentals of AC and DC electric circuits. Design and use of filter, diode, transistor, and op-amp circuits. Introduction to digital electronics, microcomputers, and interfacing.

PHY 316/Intermediate Physics for Medicine and Biology **1 course unit**

(alternate years)

Prerequisite: PHY 202

Study of physics that has medical and biological applications. The course will include topics such as: bioelectromagnetism (including nerve and muscle cell impulses, and EKG and EEG theory); emission and absorption of radiation; thermodynamics of living systems; fundamentals of imaging; ultrasound; x-rays, CAT scans, magnetic resonance imaging (MRI), and PET scans; the physics involved in nuclear medicine, such as gamma and positron emission. The course will provide a background needed by undergraduates as they prepare for biophysics, medicine, and medical physics professions.

PHY 321/Modern Physics **1 course unit**

(with laboratory)

(every fall)

Prerequisite: PHY 202

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 special theory of relativity, wave-particle duality, quantization of energy, Schrödinger equation, potential wells, and atomic physics. Experimental basis for modern physics is also discussed.

PHY 393/Independent Research I **1 course unit**

(every semester)

Prerequisite: 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. This course is reserved for students of junior standing with a GPA of 2.5 or higher.

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

(alternate years)

Prerequisite: PHY 306

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, Lagrangians, and Hamiltonians. Scientific programming is used extensively in problem solving.

PHY 411/Optics and Wave Motion **1 course unit**
(with laboratory)
(alternate years)

Prerequisites: PHY 306, or permission of instructor

A study of the properties of light and its interaction with matter. The areas of geometric, wave, and quantum optics are treated at an intermediate level.

PHY 413/General Relativity and Cosmology **1 course unit**
(occasionally)

Prerequisite: PHY 306 or MAT 129

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 416/Thermodynamics **1 course unit**
(offered in alternate years)

Prerequisite: PHY 306

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 421/Electromagnetic Theory I **1 course unit**
(alternate years)

Prerequisite: PHY 306

A study of the electric and magnetic properties of matter with emphasis on fields, energy exchanges, and practical applications in electromagnetic fields.

PHY 422/Electromagnetic Theory II **1 course unit**
(alternate years)

Prerequisite: PHY 421, or permission of instructor

A study of the theory and laws of classical electromagnetism on an intermediate level. Emphasis will be given to electrostatic charge distributions, potential theory, Maxwell's equations, and electromagnetic waves.

PHY 426/Particle and Nuclear Physics **1 course unit**
(alternate years)

Prerequisites: PHY 321, CSC 215

Quantum mechanical treatment of alpha decay, electron and positron emission, gamma radiation, nuclear models, nuclear reactions, parity, isospin, fission, fusion, fundamental particles, and antimatter.

PHY 431/Introduction to Quantum Mechanics **1 course unit**
(alternate years)

Prerequisites: PHY 306, PHY 321

Fundamental concepts of quantum mechanics and applications to problems in modern physics. Wave mechanics and wave mechanical properties of matter studied using the Schroedinger approach.

PHY 436/Solid State Physics **1 course unit**
(alternate years)

Prerequisites: PHY 321, PHYS 306

Corequisite: PHY 421

Topics: crystal structure, diffraction of X-ray by crystals, lattice vibrations, thermal properties, free electron theory of metals, band theory, semiconductors, superconductors, and magnetism.

PHY 451/Advanced Physics Laboratory **1 course unit**
(alternate years)

Prerequisites: PHY 306, PHY 321

Performance of physics experiments at an advanced level. Statistical treatment of data approaching that of research caliber applied to experiments of classical and modern format. Involvement in research.

PHY 466/Introductory Astrophysics **1 course unit**
(occasionally)

Prerequisites: PHY 321, CSC 215, or permission of instructor

Observational data and physics of stars and stellar systems including: atomic structure and radiative processes; thermostatics of excitation and ionization equilibria; photometry and spectroscopy; radiation transport, absorption, and scattering theory; thermodynamics of stellar structure and evolution; thermonuclear fusion reactions and nucleosynthesis; galactic structure and evolution; and cosmology.

PHY 493/Independent Research II **1 course unit**
(every semester)

Prerequisites: 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. This course is reserved for students of senior standing with a GPA of 2.5 or higher.

AST 161/Introduction to Astronomy **1 course unit**
(with laboratory)

(every semester)

Same as PHY 161

Prerequisite: Completion of College Basic Skills requirements

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 properties, origin, and evolution of (1) the solar system, and (2) stars and stellar systems, including galaxies; and cosmology. Laboratory sessions will involve an investigation of observable celestial phenomena, including 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.

AST 261/Astronomy II **1 course unit**
(with laboratory)
(occasionally)

Prerequisite: AST 161 or PHY 161

Study of the stellar universe. Topics: stellar properties, multiple stars, star clusters, variable stars, interstellar medium, stellar evolution, galaxies, and cosmology. Laboratory exercises involve use of computer software, telescopes, photometers, and spectroscopes.

GEO 120/Introduction to Geology **1 course unit**
(with laboratory)
(every semester)

Same as PHY 120

Prerequisite: Completion of College Basic Skills requirements

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.

GEO 220/Advanced Geology **1 course unit**
(with laboratory)
(spring semester)

Same as PHY 220

Prerequisite: GOL 120 or PHY 120

Earth history as recorded by the rock record is emphasized. Topics include: determining Earth origin and age, sediments and sedimentary structures, marine and non-marine environments of deposition, and Geologic time. Field trips to the following locations are required: The American Museum of Natural History, Sterling Hill Mine, Central New Jersey, Northern New Jersey, and Eastern Pennsylvania. Small fees are associated with each trip.

MET 171/Introduction to Meteorology **1 course unit**
(with laboratory)
(fall semester)

Same as PHY 171

Prerequisite: Completion of College Basic Skills requirements

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.

SCI 103/Earth and Physical Science **1 course unit**
(with laboratory)

Prerequisite: Completion of College Basic Skills requirements

This non-calculus course satisfies the Physics Standard 5.7 and the Earth Science Standard 5.8. Physics Component: mechanics, fluids, heat, resonance, optics, and electromagnetism. Earth Science Component: Sun's path and seasons, global pressure and wind belts, minerals, rocks, topographic maps, and relative and absolute dating. Includes in-class experiments and demonstrations that future science educators can adapt for elementary school physical science instruction.