

## Physics

*Faculty:* Ochoa, *Chair:* Becker, Dalafave, Gleeson, Hiack, Kolp, Pfeiffer, Wickramasinghe

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, environmental science, or graduate school in professions 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": PHYS 201 (C-), PHYS 202 (C-), PHYS 321 (C-).
- Transfer in the program from another program within the College is based upon the following performance standards in these "foundation course": PHYS 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: PHYS 201 (C-), PHYS 202 (C-), PHYS 321 (C-).

### Physics Major

#### PHYA—Physics Liberal Arts Track

Forty-three (43) credits in required physics courses

#### Suggested Course Sequence

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#### Freshman Year

PHYS	099/Physics Introductory Seminar	0
PHYS	201, 202/General Physics I, II	8
CSC	215/Computer Science I	4
MAT	127, 128/Calculus A,B	8
WRI	102/Academic Writing	4
IDSC	151/Athens to New York	3 or 4
<i>or</i>		
FSP	101/First Year Seminar	
Foreign Language*		6

**Total for year**                      **33 to 34**

*\*Students exempted from language requirements may take physics or general education electives*

#### Physics Major Required Courses                      28 cr.

PHYS	311/Electric Circuits and Electronics	4
PHYS	401/Mechanics	3
PHYS	411/Optics and Wave Motion	4
PHYS	421/Electromagnetic Theory I	3
PHYS	422/Electromagnetic Theory II	3

PHYS	416/Heat and Thermodynamics	3
PHYS	426/Particle and Nuclear Physics	3
PHYS	431/Introduction to Quantum Mechanics	3
PHYS	436/Solid State Physics	3
PHYS	451/Advanced Physics Laboratory	2
<b>Physics Major Option Courses</b>		<b>6 cr.</b>
PHYS	313/An Introduction to General Relativity	3
PHYS	316/Intermediate Physics for Medicine and Biology	3
PHYS	466/ Introductory Astrophysics	3
PHYS	499/Independent Study	variable

### Physics Major PHYC—Computational Physics Track

Thirty-six credits in required physics courses—24 credits in required math and computer science courses.

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#### Freshman Year

PHYS	099/Physics Introductory Seminar	0
PHYS	201, 202/General Physics I, II	8
CSC	215/Computer Science I	4
MAT	127, 128/Calculus A,B	8
WRI	102/Academic Writing	4
IDSC	151/Athens to New York	3 or 4
<i>or</i>		
FSP	101/First Year Seminar	
	Foreign Language*	6

**Total for year 33 to 34**

*\*Students exempted from language requirements may take physics or general education electives*

<b>Physics Options</b>		<b>17 cr.</b>
PHYS	313/An Introduction to General Relativity	3
PHYS	316/Intermediate Physics for Medicine and Biology	3
PHYS	401/Mechanics	3
PHYS	411/Optics and Wave Motion	4
PHYS	466/Introduction to Astrophysics	3
PHYS	421/Electromagnetic Theory I	3
PHYS	422/Electromagnetic Theory II	3
PHYS	416/Heat and Thermodynamics	3
PHYS	426/Particle and Nuclear Physics	3
PHYS	431/Introduction to Quantum Mechanics	3
PHYS	436/Solid State Physics	3
PHYS	451/Advanced Physics Laboratory	2
PHYS	499/Independent Study in Physics	variable

#### Math and Computer Science Options (at least 6 hrs. CMSC) 12/13 cr.

CMSC	210 Discrete Structures	3
CMSC	325/Computer Architecture	4
CMSC	340/Programming in the Large	4
CMSC	350/Computer Graphics	3
CMSC	360/Networks	3
CMSC	370/Stack Machines	3
CMSC	380/Artificial Intelligence	3
CMSC	390/Programming Languages	3
STAT	115/Statistics I	3
MAT	315/Linear Algebra	4
MATH	316 Introduction to Probability	3

## Physics Major PHYT—Physics Teacher Preparation Track

Sixteen (16) credits in required courses—nine credits of required math and computer science courses—11 credits of earth science courses, with options for an additional 23 credits in physics.

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.

### Suggested Course Sequence

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PHYS	201, 202/General Physics I, II	8
CSC	215/Computer Science I	4
MAT	127, 128/Calculus A,B	8
WRI	102/Academic Writing	4
IDSC	151/Athens to New York	3 or 4
<i>or</i>		
FSP	101/First Year Seminar	
	Foreign Language*	6

**Total for year                    33 to 34**

*\*Students exempted from language requirements may take physics or general education electives*

<b>Required Courses</b>	<b>32 cr.</b>	
PHYS	201/202/General Physics I, II	8
CSC	215/Computer Science I	4
MTRL	171/Intro. Meteorology	4
ASTR	161/Descriptive Astronomy	4
PHYS	311/Electric Circuits and Electronics	4
PHYS	321/Modern Physics	4
GOLG	120/Intro. to Geology	4

<b>Options</b>	<b>23 cr.</b>	
CHEM	340/History of Chemistry and Physics	3
PHIL	230/Philosophical Issues in Science	3
ASTR	261/Astronomy II	4
GOLG	220/Geology II	4
PHYS	306/Math Physics	3
PHYS	313/An Introduction to General Relativity	3
PHYS	316/Intermediate Physics for Medicine and Biology	3
PHYS	401/Mechanics	3
PHYS	411/Optics and Waves	4
PHYS	421/Electromagnetic Theory I	3
PHYS	422/Electromagnetic Theory II	3
PHYS	416/Heat and Thermodynamics	3
PHYS	426/Particle and Nuclear	3
PHYS	431/Intro. to Quantum Mechanics	3
PHYS	451/Advanced Physics Laboratory	2
PHYS	466/Introductory Astrophysics	3
PHYS	499/Independent Study	variable
<i>or</i>		
MATH	326/Differential Equations	3
<i>or</i>		
CHEM	353/354/Organic Chemistry I, II	8
MATH	386/Diff. Eq. and Num. Tech.	3

BIO	185/Themes in Biology	4
MATH	229/Calculus III	3

### Physics Major PHYG—Earth Science Track

Sixteen (16) credits in required physics courses—nine credits of required math and computer science courses—11 credits of earth science courses, with options for an additional 23 credits in physics.

#### Suggested Course Sequence

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#### Freshman Year

PHYS	099/Physics Introductory Seminar	0
PHYS	201, 202/General Physics I, II	8
CSC	215/Computer Science I	4
MAT	127, 128/Calculus A,B	8
WRI	102/Academic Writing	4
IDSC	151/Athens to New York	3 or 4
<i>or</i>		
FSP	101/First Year Seminar	
	Foreign Language*	6

**Total for year                    33 to 34**

*\*Students exempted from language requirements may take physics or general education electives*

#### Required Courses                    28 cr.

PHYS	201, 202/General Physics I, II	8
PHYS	321/Modern Physics	4
CSC	215/Computer Science I	4
MTRL	171/Intro. to Meteorology	4
PHYS	311/Electric Circuits and Electronics	4
ASTR	161/Descriptive Astronomy	4
GOLG	120/Intro. to Geology	4

#### Options                                    22 cr.

CHEM	340/History of Chemistry and Physics	3
PHIL	230/Philosophical Issues in Science	3
ASTR	261/Astronomy II	4
GOLG	220/Geology II	4
PHYS	306/Math Physics	3
PHYS	313/An Introduction to General Relativity	3
PHYS	316/Intermediate Physics for Medicine and Biology	3
PHYS	401/Mechanics	3
PHYS	411/Optics and Waves	4
PHYS	421/Electromagnetic Theory I	3
PHYS	422/Electromagnetic Theory II	3
PHYS	416/Heat and Thermodynamics	3
PHYS	426/ Particle and Nuclear	3
PHYS	431/Intro. to Quantum Mechanics	3
PHYS	451/Advanced Physics Laboratory	2
PHYS	466/Introductory Astrophysics	3
PHYS	499/Independent Study	variable
<i>or</i>		
MATH	326/Differential Equations	3
<i>or</i>		
CHEM	353/354/Organic Chemistry I, II	8
MATH	386/Diff. Eq. and Num. Tech.	3
BIO	185/Themes in Biology	4
MATH	229/Calculus III	3
BIO	261/Ecology and Field Biology	4
BIOL	321/Genetics	4

## 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, biology, chemistry, physics, and technology. Students electing a physics specialization will complete 42 credits of “core” requirements including Calculus (MAT 127–128), Principles of Biology (BIOL 181–182), Principles of Chemistry (CHEM 101–102), General Physics (PHYS 201–202), Introduction to Human Technological Behavior (TSNG 171), Principles of Structures and Mechanisms (TSNG 211), and an M/S/T-approved elective. The physics specialization consists of a minimum of 21 credits including the core physics courses, (PHYS 311/Electrical Circuits and Electronics), (PHYS 306/Math Physics), (PHYS 321/Modern), one advanced physics elective course at the 300 level or higher.

### Physics Minor

A minor in physics requires a total of 20 to 21 credits in physics courses. The required courses are PHYS 201/202 (General Physics I and II), PHYS 321 (Modern Physics), and PHYS 306 (Mathematical Physics). Two advanced physics courses (300 level or higher) must be added with the approval of the department chair.

PHYS 201, 202/General Physics I, II	8
PHYS 306/Math Physics	3
PHYS 321/Modern Physics	4
Two advanced courses elected with the prior approval of the physics department chair	5–6
<b>Total required</b>	<b>20–21</b>

#### PHYS 121, 122/Principles of Physics I, II 4, 4 cr.

(3 class hours, 2 lab hours)

(annually)

Not for science or mathematics majors

Physical laws and concepts which clarify understanding of the physical environment. Stress on unity of physical ideas. Topics in PHYS 121: force, motion, momentum, energy, and gravitation. PHYS 122: wave motion, electric charges and fields, magnetism, light, and atomic & nuclear physics.

#### PHYS 191, 192/College Physics I, II 4, 4 cr.

(3 class hours, 2 lab hours)

(occasionally)A course emphasizing the important principles and concepts of physics. PHYS 191 includes mechanics, wave motion, and sound; PHYS 192 includes heat, electricity, light, and modern physics.

#### PHYS 201, 202/General Physics I, II 4, 4 cr.

(3 class hours, 2 lab hours)

(every semester)

*Corequisite* for PHYS 201: MAT 127

*Corequisite* for PHYS 202: MAT 128

Perspectives on the World: Science

PHYS 201: Mechanics and wave motion. PHYS 202: Heat, light, electricity, and magnetism. Emphasizes understanding basic principles and concepts of physics. Use of problem solving is an integral part of course.

#### PHYS 306/Mathematical Physics 3 cr.

(3 class hours)

(annually—spring)

*Prerequisites:* PHYS 202, 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.

#### PHYS 311/Electrical Circuits and Electronics 4 cr.

(3 class hours, 2 lab hours)

(alternate years)

*Prerequisite:* PHYS 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.

#### PHYS 313/An Introduction to General Relativity and Cosmology 3 cr.

(3 class hours)

(alternate years)

*Prerequisite:* PHYS 306

Study of the modern concepts of space and time. Systematic formulation of Einstein’s Theory of Gravitation–The General Theory of Relativity. Emphasizes the applications of the theory to astrophysical problems including the dynamics of the observed universe. Also emphasizes the origin of the universe from the big bang and its subsequent evolution.

**PHYS 316/Intermediate Physics for Medicine and Biology**                      **3 cr.**

(3 class hours)  
(alternate years)

*Prerequisite:* PHYS 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.

**PHYS 321/Modern Physics**                      **4 cr.**

(3 class hours, 2 lab hours)  
(annually—fall)

*Prerequisites:* PHYS 202, MAT 128

Fundamental concepts of 20th-century physics to include topics in special relativity, quantum theory, and atomic physics.

**PHYS 390/Methods of Teaching Science**                      **3 cr.**

(3 class hours)  
(annually—spring)

Modern trends in content, methods, techniques, organization, and philosophy of science education. Preparation for student teaching.

**PHYS 401/Mechanics**                      **3 cr.**

(3 class hours)  
(alternate years)

*Prerequisites:* MATH 326 or 386, PHYS 202, PHYS 306, CSC 215

Classical mechanics including kinematics, dynamics, work and energy, gravitation, harmonic oscillations, translational and rotational motion of rigid bodies, properties of solid and liquids, and wave motion.

**PHYS 411/Optics and Wave Motion**                      **4 cr.**

(3 class hours, 2 lab hours)  
(alternate years)

*Prerequisites:* PHYS 202, PHYS 306, MAT 128, CSC 215, 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.

**PHYS 416/Heat and Thermodynamics**                      **3 cr.**

(3 class hours)  
(alternate years)

*Prerequisites:* PHYS 202, PHYS 306, CSC 215

Concepts of heat and temperature and interrelationship between energy and the physical properties of matter.

**PHYS 421/Electromagnetic Theory I**                      **3 cr.**

(3 class hours)  
(annually—fall)

*Prerequisites:* PHYS 202, PHYS 306, CSC 215

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

**PHYS 422/Electromagnetic Theory II**                      **3 cr.**

(3 class hours)  
(alternate years)

*Prerequisites:* PHYS 421, PHYS 306, CSC 215, 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.

**PHYS 426/Particle and Nuclear Physics**                      **3 cr.**

(3 class hours)  
(alternate years)

*Prerequisites:* PHYS 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.

**PHYS 431/Introduction to Quantum Mechanics**      **3 cr.**

(3 class hours)  
(alternate years)

*Prerequisites:* PHYS 306, PHYS 321, CSC 215

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

**PHYS 436/Solid State Physics**      **3 cr.**

(3 class hours)  
(alternate years)

*Prerequisites:* PHYS 321, PHYS 306

*Corequisite:* PHYS 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.

**PHYS 451/Advanced Physics Laboratory**      **2 cr.**

(4 lab hours)  
(alternate years)

*Prerequisites:* PHYS 202, PHYS 306, PHYS 321, CSC 215

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.

**PHYS 466/Introductory Astrophysics**      **3 cr.**

(3 class hours)  
(occasionally)

*Prerequisites:* PHYS 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.

**PHYS 489/Physics Teaching Seminar**      **1 cr.**

(every semester)

Analysis of student-teaching experience which must be taken concurrently with PHYS 490.

**PHYS 490/Student Teaching in Physics**      **10 cr.**

(every semester)

*Prerequisites:* Meeting all criteria for admission to student teaching

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.

**PHYS 499/Independent Study in Physics**      **variable cr.**

(class hours individually arranged)  
(every semester)

*Prerequisite:* Permission of instructor

Independent study in a selected area of physics, geology, meteorology, or astronomy through the use of scientific journals, source books, and experimentation. This course may be repeated for credit if the topic is different.

**ASTR 161/Descriptive Astronomy**      **4 cr.**

(3 class hours, 2 lab hours)  
(every semester)

Study of celestial bodies. Topics: earth and its motions, celestial sphere, properties of the solar system, stars, stellar evolution, galaxies, cosmology, time, and calendar. Evening observations with telescopes and planetarium demonstrations included. Laboratory exercises involve use of computer software, star charts, the planetarium, and telescopes.

**ASTR 261/Astronomy II**      **4 cr.**

(3 class hours, 2 lab hours)  
(occasionally)

*Prerequisite:* ASTR 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.

**GOLG 120/Introduction to Geology**

**4 cr.**

(3 class hours, 2 lab hours)

(every semester)

Perspectives on the World: Science

An introductory course in the principles of geology. Topics: minerals, rocks, topographic maps, New Jersey geology, rivers, glaciers, groundwater, deserts and wind, shorelines and ocean basins, earthquakes, volcanoes and Earth's interior, plate tectonics, structural geology and geologic time.

**GOLG 220/Geology II**

**4 cr.**

(3 class hours, 2 lab hours)

(every spring)

*Prerequisite:* GOLG 120

An in-depth study of geology, focusing on earth history and geologic time. Topics: sedimentology, stratigraphy, marine and non-marine depositional environments, relative and absolute time, and basic paleontology. Several required field trips and individual case studies are included in the course.

**MTRL 171/Introduction to Meteorology**

**4 cr.**

(3 class hours, 2 lab hours)

(every fall)

A study of basic weather processes. Topics: Earth-atmosphere system, heat balance, moisture and precipitation, air masses, fronts, storm systems, ocean circulation, climate, atmospheric optics, air pollution, satellite imagery, and interpretation. Laboratory exercises involve use of computer software, weather maps, and meteorological instruments.