PHYSICS

Overview

The physics program is designed to provide a thorough grounding in the central areas of physics, allowing for flexibility in pursuing individual interests in depth. It addresses the needs of both majors and non-majors through courses and tutorials in theoretical, experimental, and computational physics. Students participating in the physics program become familiar with the facts and processes of physics and learn to think logically. Those whose interests expand beyond the introductory level will find small classes, intensive work, and challenging projects. They will also find state-of-the-art equipment for doing research in the laboratory, including an atomic force microscope, a micro-Raman spectrometer, an X-ray diffractometer, a micro-spectrophotometer, a Q switched Nd:YAG laser with second and fourth harmonic emission and an Optical Spectroscopy and Nanomaterials Laboratory.

An essential part of our Physics Area of Concentration (AOC) program is undergraduate research leading to the completion of the senior thesis. We are experienced and well-equipped to offer projects in a wide range of areas. In addition, our students routinely do paid summer research at universities and government laboratories around the country as part of the NSF-funded Research Experiences for Undergraduates (REU) program. We offer coursework and real-life experimental projects carried out in the Optical Spectroscopy and Nanomaterials Laboratory, to support engineering physics interests. Such courses include Laser Physics, Materials Science, and Analog Electronics.

We also offer Joint Areas of Concentration. Quite common at New College are AOCs combining two disciplines, with study in each not necessarily sufficient for a major in either (e.g. Physics/Mathematics). For a Joint AOC in Physics, we require a two-semester Introductory Physics sequence (with two semesters of lab), Classical Mechanics, Electricity and Magnetism, and Modern Physics (with lab). In addition, co-requisite courses in mathematics are required. The senior thesis should be related to physics. Some of our graduates go on to work for industry or government, but most continue their education in graduate school.

The physics faculty teach general education courses for non-majors. In addition to the introductory physics sequence taken by most science students, the physics faculty periodically offer courses such as Descriptive Astronomy, The Structure of Nature, and Seeing the Light, open to all students interested in exploring fundamental questions about the physical universe.

Faculty in Physics

Donald Colladay (https://www.ncf.edu/directory/donald-colladay/), Professor of Physics
George Ruppeiner (https://www.ncf.edu/directory/george-ruppeiner/), Professor of Physics and Astronomy
Mariana Sendova (https://www.ncf.edu/directory/mariana-sendova/), Professor of Physics

Requirements for the AOC in Physics

A minimum of eighteen (18) academic units.

Code	Title
Required Courses	
PHYS 2525	Physics I (Calculus-based)
PHYS 2510	Physics I Laboratory
PHYS 2575	Physics II (Calculus-based)
PHYS 2555	Physics II Laboratory
PHYS 4100	Classical Mechanics
PHYS 4250	Electricity and Magnetism
PHYS 3450	Modern Physics*
PHYS 3460	Modern Physics Laboratory
PHYS 4500	Physical Optics
PHYS 4300	Quantum Mechanics
PHYS 4100	Classical Mechanics
PHYS 4050	Solid State Physics (for students planning to do a thesis in Professor Sendova's laboratory)
Co-Requisite Courses in Mathematics	
MATH 2311	Calculus I
MATH 2312	Calculus II*
MATH 2313	Calculus III
MATH 3105	Linear Algebra
MATH 3330	Ordinary Differential Equations
Additional Requirements	
Independent Study Project (ISP) in an advanced area of Physics	
Senior Thesis in Physics and Baccalaureate Exam	

Requirements for the Joint AOC in Physics

A minimum of thirteen (13) academic units.

Code	Title
Required Courses	
PHYS 2525	Physics I (Calculus-based)
PHYS 2510	Physics I Laboratory
PHYS 2575	Physics II (Calculus-based)
PHYS 2555	Physics II Laboratory
PHYS 4100	Classical Mechanics
PHYS 4250	Electricity and Magnetism
PHYS 3450	Modern Physics*
PHYS 3460	Modern Physics Laboratory
Co-Requisite Courses in Mathematics	
MATH 2311	Calculus I
MATH 2312	Calculus II*
MATH 2313	Calculus III
MATH 3105	Linear Algebra
MATH 3330	Ordinary Differential Equations

Physics Facilities

Optical Spectroscopy and Nanomaterials Laboratory

This research and education facility is the only laboratory of its kind at an undergraduate institution in the United States. The lab offers students opportunities to pursue a program of research and study in applied physics, particularly in nanomaterials science and engineering. The lab consists of four major research-grade optical spectroscopy instruments: a UV-VIS micro-spectrometer with polarization, temperature, and atmosphere capabilities; a Raman micro-spectrometer with two excitation wavelengths and with polarization, temperature, and

atmosphere capabilities; a Fourier transform infrared micro-spectrometer (m-FTIR) with ATR objective; and a photoluminescence spectrometer with temperature and time-decay capabilities. In addition, the lab has an atomic force microscope (AFM); a differential scanning calorimeter (DSC); three high-power compact laser systems for in-situ modification; heating and electric probe microscope stages; and a variety of instruments for sample preparation, including high temperature furnaces, a spin coater, a sputter coater, an analytical microbalance, a digital press, an acoustical and vibrational isolation chamber, and optical vibration free tables.

The physics labs are equipped to support full semester courses in Introductory Lab (2 semesters), Modern Physics Lab, Electronics Lab, and Optics Lab. The introductory physics lab is fully computerized to allow interfacing of equipment to computers, and instant analysis and display of results. Beyond the regular course level, there are laboratories for doing advanced projects. These include measuring the speed of light with a rotating mirror apparatus, measuring the strength of gravity with a Cavendish setup, studying crystal structure with X-rays, making electronic measurements on semiconductors, performing optical experiments with lasers, doing precision optical interferometry, analyzing acoustical signals with a spectrum analyzer, and making nuclear counts with a multichannel analyzer. The physics program also has two computer-controlled optical telescopes, a Meade 10.5" LX200 and a Meade 127ED 5" refractor.

Representative Senior Theses in Physics

- Surface Plasmon Resonance of Noble Metal Nanoparticles in Thin Film Dielectric Matrices
- Star Formation and Metallicity in Irregular Galaxies
- The Physics of Tachyons
- Carbon Nanoparticles
- Sequestration and Stabilization: Taming the Black Hole
- Using Homotopy Groups to Detect Topological Defects with Applications to a Lorentz -Violating Theory
- Quantum Chemistry & Applications of Density Functional Theory to the C1-/Benzene Adduct
- Curved Periodic Crack Patterns in Sol-gel Films
- Coil Impedance in the Presence of an Axially Symmetric Conductor
- Materials Science and Metrology in Physics
- Raman Spectroscopy of Carbon Nanotubes