

# DEPARTMENT OF PHYSICS AND ENGINEERING

*College of the Sciences and Mathematics*

## Overview

367 The Sciences & Engineering Center and The Commons  
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Department of Physics and Engineering (<http://www.wcupa.edu/physics/>)

Matthew Waite ([mwaite@wcupa.edu](mailto:mwaite@wcupa.edu)), *Chairperson*

Bob Thornton ([rthornton@wcupa.edu](mailto:rthornton@wcupa.edu)), *Assistant Chairperson*

The Department of Physics and Engineering offers two undergraduate degree programs:

- The **B.S. in Physics** is designed as preparation for graduate school or careers in government or industry. The curriculum includes a strong foundation in mathematics and the humanities. A wide choice of electives in the program provides the flexibility to develop a minor in a related area of interest.
- The **B.S. in Physics/B.S. in Engineering** is a cooperative, dual-degree, five-year engineering program with The Pennsylvania State University at University Park, Philadelphia University, Columbia University, and Case Western Reserve University.

## Scholarships/Awards

### Physics

The **Robert M. Brown Endowed Scholarship for Physics** was established in 1997 by Mr. Robert M. Brown. Partial tuition scholarships are awarded annually on a competitive basis to students in the physics program.

The **Dr. Michael F. Martens Award** was established by a bequest of the estate of Dr. Martens, a faculty member of the Department of Physics and Engineering. Dr. Martens was a long-time member of the Lions Club of West Chester, which administers the funds for the award. The award is for achievement in Physics. Awards are determined by the department's faculty.

Other awards include the **Benjamin Faber Award** in physics and mathematics, awarded to an exemplary non-traditional physics or mathematics major; the **Dr. Gary Pascuzzo Scholarship**, which is given to one or more students in SCI 102 who are engaged in and excel in the course and who show promise to transfer the knowledge gained in the course to their own classroom; and the **Dr. Russell K. Rickert Award for Undergraduate Student Research**, which recognizes up to two students who have demonstrated a sustained and significant commitment to undergraduate research. Awards shared with other departments at WCU include the **Richard '59, M '69 and Jeanette Merion Scholarship**, which is awarded to a sophomore, junior, or senior physics, chemistry, or biology major for academic excellence, with preference given to a ROTC participant; the **Diane and Roger Casagrande Scholarship** for students in pre-engineering or communication studies; and the **Yarosewick Family Scholarship**, which supports a fourth-year science major pursuing a B.S.Ed. who has a GPA of at least a 3.2 (in physics, chemistry, biology and earth/space science).

These awards are granted annually at an induction ceremony for new members of the West Chester University chapter of Sigma Pi Sigma, the national physics honor society.

The physics programs can also be found on the Internet: <http://www.wcupa.edu/physics> (<http://www.wcupa.edu/physics/>).

## Cooperative Physics/Engineering Programs

The Department of Physics and Engineering offers multiple 3+2 Physics-Engineering Programs. These are dual-degree programs in which a student typically spends three years at West Chester and two years at one of our partner institutions, after which a student

holds a B.S. in Physics from West Chester University and a bachelor's degree in engineering from the partner institution. Currently, WCU has agreements with Penn State University (main campus), Thomas Jefferson University, Columbia University, and Case Western Reserve University.

Admission to one of the affiliate engineering institutions is contingent upon a recommendation from the Department of Physics and Engineering and the student having maintained the overall average for the specific engineering program. Check with an advisor in Physics for updates on program availability and GPA requirements. Transfer students and students who have completed a bachelor's degree are not eligible for the Penn State program.

## Programs

### Majors

- B.S. in Physics (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/physics-engineering/physics-bs/>)
- B.S. in Physics/B.S. in Engineering (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/physics-engineering/physics-bs-engineering-bs/>)

### Minor

- Physics (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/physics-engineering/physics-minor/>)

## Policies

- See undergraduate admissions information. (<http://catalog.wcupa.edu/general-information/admissions-enrollment/undergraduate-admissions/>)
- See academic policies. (<http://catalog.wcupa.edu/undergraduate/academic-policies-procedures/>)

All undergraduate students are held to the academic policies and procedures outlined in the undergraduate catalog. Students are encouraged to review departmental handbooks for program tips, suggested course sequences, and explanations of procedures. When applicable, additional policies for specific department programs may be listed below.

## Admission Policy for the Department of Physics and Engineering

For admission to the physics program, most students should have completed, in addition to the general University requirements, one year each of high school chemistry and physics, and a minimum of three years of mathematics, including algebra and trigonometry, and be prepared to start calculus. Any student with a deficiency must complete WRT 120 and MAT 161 with grades of C- or better to be admitted to the program.

## Transfer Policy for the Department of Physics and Engineering

Transfer students must take a minimum of six credits at West Chester at the 250 level or above. A 2.0 GPA or better must be maintained for all physics courses.

## Advanced Placement Policy for the Department of Physics and Engineering

Visit the Registrar's website (<https://www.wcupa.edu/registrar/testCredit.aspx>) for information on how course credit for success on AP exams in physics is awarded.

## Faculty

### Professors

Kevin B. Aptowicz (kaptowicz@wcupa.edu) (2005)  
B.S., Columbia University; M.S., University of Colorado; Ph.D., Yale University

Anil Kumar Kandalam (akandalam@wcupa.edu) (2012)  
B.Sc., Osmania University; M.Sc., University of Hyderabad; Ph.D., Michigan Technological University

Robert J. Thornton (rthornton@wcupa.edu) (2008)  
Assistant Chairperson, Physics and Engineering  
B.S., Lehigh University; Ph.D., University of Hawaii

### Associate Professors

Tianran Chen (tchen@wcupa.edu) (2014)  
B.S., Zhejiang University; Ph.D., University of Minnesota

Brandon Mitchell (bmitchell@wcupa.edu) (2016)  
B.S., SUNY Fredonia; M.S., Ph.D., Lehigh University

Ian A. Morrison (imorrison@wcupa.edu) (2016)  
A.B., Bowdoin College; M.S., Ph.D., University of California, Santa Barbara

Shawn Pfeil (spfeil@wcupa.edu) (2012)  
B.S., University of California, San Diego; M.A., Ph.D., University of California, Santa Barbara

Jeffrey Sudol (jsudol@wcupa.edu) (2007)  
B.A., Macalester College; Ph.D., University of Wyoming

Matthew M. Waite (mwaite@wcupa.edu) (2001)  
Chairperson, Physics and Engineering  
B.A., Gettysburg College; Ph.D., University of Delaware

## Courses

### NSC

#### NSC 200. Tools of Nanoscience. 3 Credits.

This survey course introduces students to the major concepts and techniques of nanoscience through lectures and demonstrations. This survey is intended to be phenomenological and conceptual, setting the stage for the exploration of experimental nanoscience. Students will be introduced to why nanoscale objects are different, how to make them, how to characterize them, and how to visualize them.

Pre / Co requisites: NSC 200 requires a prerequisite of SCI 111.

Typically offered in Spring.

### PHY

#### PHY 100. Elements of Physical Science. 3 Credits.

A study of motion, energy, light, and some aspects of modern physics.

Gen Ed Attribute: Science Distributive Requirement.

Distance education offering may be available.

Typically offered in Fall & Spring.

#### PHY 105. Structure of the Universe. 3 Credits.

A survey of phenomena and objects in the universe from the very smallest distance scales to the grandest in the cosmos. Includes a historical consideration of the developments of modern theories of the physical world.

Gen Ed Attribute: Science Distributive Requirement.

Typically offered in Fall & Spring.

#### PHY 115. Engineering Graphics I. 1 Credit.

Use and preparation of engineering drawings. Topics include the use of instruments, linework, geometric construction, lettering, four types of projections, dimensioning, and sections.

Typically offered in Fall.

#### PHY 116. Engineering Graphics II. 1 Credit.

A continuation of PHY 115, to include topics such as layout, detail, and assembly drawings, developments, auxiliary drawings, various types of drafting, machine tool processes, and computer drafting.

Pre / Co requisites: PHY 116 requires prerequisite of PHY 115.

Typically offered in Spring.

#### PHY 123. Food, Fire, and Physics: The Science of Cooking. 3 Credits.

An exploration of food and cooking from a physical science perspective. Principles of soft matter physics (e.g. phase diagram, intermolecular forces, viscosity, diffusion, self-assembly, polymer physics) are discussed and used to gain insight into food and cooking.

Gen Ed Attribute: Science Distributive Requirement.

Typically offered in Fall & Spring.

#### PHY 125. Theology and Science: Enemies or Partners. 3 Credits.

An inquiry into the relationship of theology to the natural sciences. Team taught by both a physicist and a philosopher, the course investigates how ideas of God have been affected by advances in physics and biology.

Gen Ed Attribute for Students Admitted Prior to Fall 2020: Humanities Distributive Requirement, Science Distributive Requirement.

Gen Ed Attribute for Students Admitted Fall 2020 and After: None.

Typically offered in Spring.

Cross listed courses PHI 125, PHY 125.

#### PHY 130. General Physics I. 4 Credits.

An introductory, noncalculus, physics course. Mechanics of solids and fluids, wave motion, heat and temperature, thermodynamics, and kinetic theory.

Gen Ed Attribute: Science Distributive Requirement.

Typically offered in Fall, Spring & Summer.

#### PHY 140. General Physics II. 4 Credits.

An extension of PHY 130. Electricity and magnetism, geometrical and physical optics, and modern physics.

Pre / Co requisites: PHY 140 requires a prerequisite of PHY 130.

Typically offered in Fall, Spring & Summer.

#### PHY 170. Physics I. 4 Credits.

An introductory laboratory-based course. Includes mechanics, waves, heat, and thermodynamics. The laboratory emphasizes error analysis, the writing of technical reports, and data analysis using computers. A laboratory section must be added along with the lecture and discussion.

Pre / Co requisites: PHY 170 requires a prerequisite of MAT 161 OR a prerequisite of MAT 143 or MAT 145 and a corequisite of MAT 161.

Gen Ed Attribute: Science Distributive Requirement.

Typically offered in Fall & Spring.

#### PHY 180. Physics II. 4 Credits.

A continuation of PHY 170. Includes electricity and magnetism, geometrical and physical optics, electronics, and modern physics.

Pre / Co requisites: PHY 180 requires a prerequisite of PHY 170 and corequisite of MAT 162.

Typically offered in Fall & Spring.

#### PHY 205. Cellular and Molecular Biophysics. 3 Credits.

This course draws on concepts and tools from physics, biology, and chemistry to understand how energy is transformed into order in living systems. This will require students to consider the roles evolution, polymer physics, and chemistry have played in shaping the machinery of life. This course is aimed at students from physics, biology, and chemistry who are interested in stretching themselves beyond disciplinary boundaries.

Pre / Co requisites: PHY 205 requires prerequisites of PHY 130 or PHY 170, CHE 103, and one of MAT 143, MAT 145, or MAT 161; and a corequisite of PHY 140 or PHY 180.

Gen Ed Attribute: Interdisciplinary Requirement, Speaking Emphasis.

Typically offered in Spring.

#### PHY 240. Introduction to Modern Physics. 3 Credits.

An atomic view of electricity and radiation, atomic theory, special relativity theory, X-rays, radioactivity, nuclear fission, and introductory quantum mechanics.

Pre / Co requisites: PHY 240 requires prerequisites of PHY 140 or PHY 180 and MAT 162.

Typically offered in Spring.

**PHY 260. Engineering Statics. 3 Credits.**

Composition and resolution of forces, equivalent force systems, equilibrium of particles and rigid bodies, centroids and center of gravity, analysis of simple structures, internal forces in beams, friction, moments and products in inertia, and methods of virtual work.

Pre / Co requisites: PHY 260 requires prerequisites of PHY 130 or PHY 170 and MAT 162.

Typically offered in Spring.

**PHY 275. Computational Physics. 3 Credits.**

This is an introductory course on the basic ideas and programming skills of computational physics, with a seven-week introduction to programming given at the beginning of the course. Students will develop their own computer software to solve problems in mechanics, electrostatics, magnetism, quantum mechanics, chaos and other areas.

Pre / Co requisites: PHY 275 requires a prerequisite of MAT 162 and a corequisite of PHY 180.

Typically offered in Spring.

**PHY 300. Mechanics. 3 Credits.**

Particle kinematics, dynamics, energy, and momentum considerations; oscillations; central force motion; accelerated reference frames; rigid body mechanics; Lagrangian mechanics.

Pre / Co requisites: PHY 300 requires prerequisites of PHY 140 or PHY 180 and MAT 162.

Typically offered in Fall.

**PHY 310. Intermediate Physics Lab: Experimental Methods & Scientific Communication. 3 Credits.**

A lecture and laboratory course designed to familiarize students with experimental physics and scientific communication. Students conduct experiments, analyze data, and come to evidence-based conclusions. In addition, explicit instruction occurs on writing and presenting in the discipline of physics. Students write a scientific report on an experiment and present their findings to the department.

Pre / Co requisites: PHY 310 requires prerequisites of PHY 240 and PHY 275.

Gen Ed Attribute: Speaking Emphasis, Writing Emphasis.

Typically offered in Fall & Spring.

**PHY 330. Electronics I. 3 Credits.**

Emphasis is divided between theory and experiment. The course begins with a brief review of resistive and RC voltage dividers. Electronic circuits studied include basic operational amplifiers, timers, instrumentation amplifiers, logic circuits, flip flops, counters, and timers.

Pre / Co requisites: PHY 330 requires prerequisites of MAT 161 and PHY 140 or PHY 180.

Typically offered in Spring.

**PHY 350. Heat and Thermodynamics. 3 Credits.**

Equations of state, first and second laws of thermodynamics, ideal and real gases, entropy, and statistical mechanics.

Pre / Co requisites: PHY 350 requires prerequisites of PHY 275, PHY 240, and MAT 261.

Typically offered in Spring.

**PHY 370. Mathematical Physics. 3 Credits.**

Selected topics in mathematics applied to problems in physics, ordinary differential equations, vector calculus, Fourier analysis, matrix algebra, and eigenvalue problems.

Pre / Co requisites: PHY 370 requires prerequisites of PHY 275, PHY 180, MAT 261, MAT 315 or (MAT 311 and MAT 343), or instructor permission.

Typically offered in Fall.

**PHY 390. Fundamentals of Astrophysics. 3 Credits.**

An advanced physics course that deals with a broad range of topics in modern astrophysics.

Topics include, but are not limited to, astronomical measurements, celestial mechanics, radiative transfer theory, stellar structure, and both newtonian and relativistic cosmology.

Pre / Co requisites: PHY 390 requires prerequisites of PHY 275 and PHY 240.

Typically offered in Spring.

**PHY 410. Optics. 3 Credits.**

Geometrical and physical optics. Reflection and refraction at surfaces, lenses, interference and diffraction, and polarization.

Pre / Co requisites: PHY 410 requires prerequisites of MAT 261, MAT 315, and PHY 275.

Typically offered in Fall.

**PHY 420. Quantum Mechanics I. 3 Credits.**

An introductory course in quantum mechanics. Topics covered include the Schrödinger equation, stationary states, time evolution, position and momentum space wave functions, bound states, scattering states, spin and orbital angular momentum, hydrogenic atoms, and entanglement. Additional topics may include perturbation theory, conserved quantities, particle statistics, and quantum information.

Pre / Co requisites: PHY 420 requires a prerequisite of PHY 240 and a corequisite of PHY 370.

Typically offered in Fall.

**PHY 425. Quantum Mechanics II. 3 Credits.**

This course is the second-semester quantum mechanics course. The following fundamental topics will be covered: Time-independent Perturbation Theory, the Variational Principle, the WKB approximation, time-dependent Perturbation Theory, and advanced topics.

Pre / Co requisites: PHY 425 requires a prerequisite of PHY 420.

Typically offered in Spring.

**PHY 430. Electricity and Magnetism I. 3 Credits.**

Electrostatics of point charges and extended charge distributions, fields in dielectrics, and magnetic fields due to steady currents. Ampere's Law and induced emfs. Topics in electromagnetic waves as time permits.

Pre / Co requisites: PHY 430 requires prerequisites of PHY 300 and MAT 343 or PHY 370.

Typically offered in Fall.

**PHY 435. Electricity and Magnetism II. 3 Credits.**

This course covers the applications of Maxwell's equations. Specific topics include: conservation laws, electromagnetic waves, guided waves, gauge transformations, retarded potentials, radiation from point charges and dipoles, and transformations of the electromagnetic field.

Pre / Co requisites: PHY 435 requires a prerequisite of PHY 430.

Typically offered in Spring.

**PHY 455. Advanced Physics Lab: Experimental Methods & Scientific Communication. 3 Credits.**

This course is a continuation of PHY 310, a lecture and laboratory course designed to familiarize students with modern physics laboratory equipment and practices through a series of experiments. Students write three research papers and give one research talk describing the experiments and their results in a style consistent with scientific conventions.

Pre / Co requisites: PHY 455 requires a prerequisite of PHY 310.

Gen Ed Attribute: Speaking Emphasis, Writing Emphasis.

Typically offered in Spring.

**PHY 480. Special Topics in Physics. 1-3 Credits.**

Topics of special interest to be presented once or twice. Enrollment requirements to be specified by the instructor. Course may be repeated by student for credit any number of times when different topics are presented.

Typically offered in Spring.

Repeatable for Credit.

**PHY 481. Special Topics with Lab. 3 Credits.**

Topics of special interest to be presented with a laboratory component. Enrollment requirements to be specified by the instructor. Course may be repeated by student for credit up to three times when different topics are presented.

Consent: Permission of the Department required to add.

Typically offered in Fall & Spring.

Repeatable for Credit.

**PHY 490. Introduction to Research. 1-9 Credits.**

Specific problems in consultation with the faculty adviser.

Consent: Permission of the Department required to add.

Typically offered in Fall.

Repeatable for Credit.

**SCI****SCI 100. Climate Change. 3 Credits.**

This course provides an introduction to the science of climate change. Core topics include albedo, the greenhouse effect, the carbon cycle, and feedback mechanisms between these phenomena. Students will study past climates, climate models, and the impacts of modern climate change. Near the end of the semester students will discuss efforts to mitigate climate change. They conclude by briefly discussing the most widely adopted climate change policies. No previous experience with these subjects is assumed.

Gen Ed Attribute: Science Distributive Requirement.

Typically offered in Fall & Spring.

**SCI 103. Science in the Arts: Color and Music. 3 Credits.**

This class will be geared towards how science shows up in art and music. Students will initially study some basic physics principles such as force and motion, electric and magnetic fields, periodic oscillations, and wave properties. They will then introduce some biological and neuropsychological concepts as they begin to focus on light, optics and color, and the human eye. Next, students will focus on sound, sound production, sound perception, and the organization of sound into musical scales such that "music" can be constructed.

Gen Ed Attribute: Science Distributive Requirement.

Distance education offering may be available.

Typically offered in Fall & Spring.

**SCI 111. Applications of Math and Reasoning in Nanoscience. 1 Credit.**

This 3-week course will expose the students to basic problem-solving skills involving polynomial, rational, exponential, logarithmic, and trigonometric functions, where an emphasis will be placed on understanding function properties, models, and graphs applied to nanoscience situations. Little to no prior knowledge of physics, biology, chemistry, or engineering is assumed. There will be a hands-on component to this course that will utilize inquiry-oriented activities with Arduinos and other experimental interfaces. An example of a hands-on activity will be the synthesis and analysis of gold nanoparticles, focusing on their use in applications such as sensory probes, drug delivery, and catalysis.

Typically offered in Summer.