PHYSICS

FACULTY:
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Why is the sky blue? Why is water wet? In seeking to understand natural phenomena as simply as possible, physicists have made a remarkable discovery: whatever questions they ask the answers ultimately involve the *same* elegant principles of energy and momentum, mass and charge. Physicists seek and study rhythms and patterns among natural phenomena, including those that are readily apparent (like the orbits of planets) and those that are apparent only to deep analysis and careful observation (like the quantum fluctuations of atoms). Abetted by the power of mathematics, they ultimately comprehend and express the fundamental regularities of the physical universe in uniquely human metaphors. In this way, the universe comes to know itself in human terms.

A Physics major provides a rigorous grounding in the scientific process and a firm scientific understanding of the world. It fosters critical thinking and provides broad practical training in science and technology. It can lead to graduate study and basic research (in a variety of disciplines), to stimulating jobs in industry, or to challenging and rewarding careers in teaching. Our faculty is engaged in original research, and our students are drawn early into collaborative research projects with faculty.

Major in Physics

Consists of fifteen courses:

- MATH 11100
- MATH 11200
- MATH 21200
- PHYS 11100
- PHYS 11200
- PHYS 20100
- PHYS 20200
- One of the following courses: PHYS 22000 or 23000
- PHYS 30100
- PHYS 30200
- PHYS 30400
- One additional 300-level course
- Junior Independent Study: PHYS 40100
- Senior Independent Study: PHYS 45100
- Senior Independent Study: PHYS 45200

Minor in Physics

Consists of six courses:

- PHYS 11100
- PHYS 11200
- PHYS 20100
- Three elective Physics courses, only one of which can be PHYS 10300, 10400, or 10500

Special Notes

- The Calculus Physics sequence PHYS 11100, 11200 is a prerequisite for the selection of Physics as a major and is best taken the first year, although one can still complete the major if the sequence is taken the second year.
- The Calculus sequence MATH 11100, 11200 must be taken at least concurrently with the Calculus Physics sequence, although MATH 10700, 10800 may substitute for MATH 11100.
- Students must have completed both the Calculus sequence (MATH 11100 and MATH 11200) and the Calculus Physics sequence (PHYS 11100 and PHYS 11200) with a grade of C- or better before enrolling in PHYS 20100.
- Those students considering graduate study in physics should also take PHYS 35000, MATH 21100, CHEM 11100, 11200, and as many advanced Physics courses as can be scheduled.
- Those students considering astronomy or astrophysics as a career should major in Physics and take PHYS 10400, 10500, and 32000.
- For students interested in engineering, Physics is a natural basis for 3-2 engineering programs, which are described under *Pre-Professional and Dual Degree Programs*. However, such students must complete enough physics in three years to complete the major in the fourth year, if necessary.
- PHYS 10300, 10400, 10500, 10700, and 10800 do not count toward a Physics major (except by special permission of the department).
- No student may receive credit for both PHYS 10700 and 11100, or for both PHYS 10800 and 11200.
- **Advanced Placement**: A student may receive credit if a score of 4 or 5 is obtained on any of the following AP examinations:

  Physics 1
  Physics 2
  Physics C: Mechanics
  Physics C: Electricity and Magnetism
- Students need to check with the chairperson of the department to determine whether they will receive one or two credits toward graduation and at what level they should begin their college Physics courses. The advanced placement policy of the College is explained in the section on *Admission*. Students who have taken a college level physics course (other than Advanced Level or AP Exam) and would like to place beyond the first Physics course need to take a placement exam that the chairperson administers.
- The laboratory and classroom components are closely integrated in Physics courses with a laboratory and must therefore be taken concurrently. The course grade and the laboratory grade will be identical and are based on performance in both components; the relative weight of the two components will be stated in each course syllabus.
- Physics majors cannot use S/NC grading option for the required courses, and the department recommends they not use it for any course in Physics, Mathematics, or Chemistry.
- Physics minors can use the S/NC grading option for no more than two of the required courses.
- Only grades of C- or better are accepted for the major or minor.

PHYSICS COURSES

PHYS 10300. PHYSICS REVOLUTIONS
Designed for non-science majors, this course explores how physics has revolutionized our understanding of the natural world. Revolutions include the unification of the terrestrial and the celestial in Newton's Mechanics; of electricity, magnetism and light in Maxwell's Electromagnetism; of space and time in Einstein's Theory of Relativity; of particles and waves in Quantum Mechanics. No mathematics beyond high school algebra is assumed. Three hours per week. *[Q, MNS]*

PHYS 10400. ASTRONOMY OF THE SOLAR SYSTEM
In just one generation, space exploration has revolutionized our understanding of the solar system. Planets, moons, asteroids and comets have been transformed from obscure and remote objects with mythical names to remarkable and detailed real worlds. In this course, we will study the surprising new solar system that the Space Age continues to reveal. Knowledge of high school algebra and trigonometry is expected. Three hours per week. *[MNS]*

PHYS 10500. ASTRONOMY OF STARS AND GALAXIES
The brilliant and sometimes fuzzy objects in the night sky are dynamic, volatile stars and gigantic galaxies. We will study the general properties of stars as well as how they evolve from birth to death. We will also study the shape and composition of galaxies and the ultimate fate of our universe. Knowledge of high school algebra and trigonometry is expected. Three hours per week. *Fall. [MNS]*

PHYS 10700. ALGEBRA PHYSICS I (Communication)
Mechanics, heat, wave motion and sound. For students who do not intend to major in physics. Students who have completed one semester of calculus with a grade of C+ or better should take PHYS 11100. Three hours per week plus laboratory. Knowledge of algebra and trigonometry is expected. *(1.25 course credits) Annually. Fall. [Q, MNS]*

PHYS 10800. ALGEBRA PHYSICS II
Optics, electricity and magnetism, and atomic and nuclear physics. Three hours per week plus laboratory. *(1.25 course credits) Prerequisite: PHYS 10700. Annually. Spring. [Q, MNS]*

PHYS 11100. CALCULUS PHYSICS I
Quantitative development of classical mechanics and thermodynamics. For students who intend to major in physics or chemistry or attend a professional school. Three hours per week plus laboratory. *(1.25 course credits.) Prerequisite: MATH 11100 (may be taken concurrently; MATH 10700-10800 may substitute for MATH 11100, but taking MATH 10700 concurrently with PHYS 11100 will defer PHYS 11200 to the next academic year). Annually. Fall. [Q, MNS]*

PHYS 11200. CALCULUS PHYSICS II
Quantitative development of classical electromagnetism and optics. Three hours per week plus laboratory. *(1.25 course credits) Prerequisite: PHYS 11100, and MATH 11200 must be taken at least concurrently. Annually. Spring. [Q, MNS]*

PHYS 20100. MODERN PHYSICS
Space-time physics (relativity, gravitation) and quantum physics (the microworld). Three hours per week plus laboratory. *(1.25 course credits) Prerequisite: PHYS 11200, or PHYS 10800 with permission of the instructor. Annually. Fall. [W, Q, MNS]*

PHYS 20200. MATHEMATICAL METHODS FOR THE PHYSICAL SCIENCES
Introduces skills of differential equations, linear algebra, and Fourier analysis essential to the physical sciences and engineering. Three hours per week. *Prerequisite: MATH 11200 and PHYS 11200. Annually. Spring.*

PHYS 22000. ELECTRONICS FOR SCIENTISTS
An introduction to the principles and applications of circuit components, operational amplifiers, oscillators, digital logic, analog-to-digital and digital-to-analog, and an introduction to *LabVIEW*. Three hours per week plus laboratory. *(1.25 course credits) Prerequisite: PHYS 10800 or 11200. Fall. [Q, MNS]*

PHYS 23000. COMPUTATIONAL PHYSICS
A project-based introduction to computer simulation that develops increasingly sophisticated numerical models of physical systems in parallel with proficiency in either a modern computer language like C++ or in computational software like *Mathematica*. Three hours per week plus laboratory. *(1.25 course credits) Prerequisite: PHYS 20100 (may be taken concurrently). Alternate years.*

PHYS 30100. MECHANICS
Viscous forces, harmonic motion, rigid bodies, gravitation and small oscillations in Newtonian mechanics, Lagrange and Hamilton formulations, computer simulation and numerical methods. Three hours per week. *Prerequisite: PHYS 11100 and MATH 21200, PHYS 20200. Annually. Fall.*

PHYS 30200. THERMAL PHYSICS
Classical and quantum treatment of problems in thermodynamics and statistical mechanics. Three hours per week. *Prerequisite: PHYS 20100. Alternate years.*

PHYS 30400. ELECTRICITY AND MAGNETISM
Introduction to classical field theory and Maxwell's equations of electromagnetism. Three hours per week. *Prerequisite: PHYS 11200, 20200, and MATH 21200. Alternate years.*

PHYS 30500. PARTICLE PHYSICS
An introduction to the concepts and techniques of nuclear and elementary particle physics. Three hours per week. *Prerequisite: PHYS 20100. Every three years.*

PHYS 31000. GENERAL RELATIVITY
A detailed introduction to relativistic gravity, gravity as spacetime curvature, the Einstein field equations, and geodesic motion. Applications include the perihelion precession of Mercury, the deflection of starlight by the sun, black holes, gravity waves, and the Big Bang expansion of the universe. Three hours per week. *Prerequisite: PHYS 20100. Every three years.*

PHYS 31500. NONLINEAR DYNAMICS
An introduction to the study of systems described by nonlinear difference or differential equations using both qualitative and numerical techniques. Topics include stability and bifurcations, extreme sensitivity to initial conditions or chaos, strange attractors and fractals. Three hours per week. *Prerequisite: PHYS 20100. Every three years.*

PHYS 32000. ASTROPHYSICS
A quantitative introduction to astronomy and astrophysics. Topics include classical astronomy; stellar structure, stellar atmospheres, and stellar evolution; galactic structure, cosmology, and cosmogony. Emphasis will be on quantitative application of physical theory to astronomical phenomena. Three hours per week. *Prerequisite: PHYS 20100. Every three years.*

PHYS 32500. CONDENSED MATTER PHYSICS
An introduction to the physics of solid and liquid matter and the relationship between fundamental atomic interactions and observable macroscopic properties. Topics include crystal structure, lattice vibrations, electronic properties, semiconductors, and mechanical properties. Three hours per week. *Prerequisite: PHYS 20100. Every three years.*

PHYS 33000. MODERN OPTICS
An introductory course in the basic concepts, principles, and theories of modern optics, including lasers. Topics include wave optics, light and matter interactions, basic laser principles, holography, and specific optical systems. Three hours per week. *Prerequisite: PHYS 20100. Every three years.*

PHYS 35000. QUANTUM MECHANICS
A rigorous introduction to the formalism and interpretation of microworld physics. Probability amplitudes, interference and superposition, identical particles and spin, 2-state systems, Schrodinger evolution, applications. Three hours per week. *Prerequisite: PHYS 20100 and 20200, and MATH 21200. Alternate years. Spring.*

PHYS 39900. SELECTED TOPICS
Advanced Quantum Mechanics, Quantum Field Theory, and others offered when sufficient student interest is shown.

PHYS 40000. TUTORIAL
Prerequisite: The approval of both the supervising faculty member and the chairperson is required prior to registration.

PHYS 40100. INDEPENDENT STUDY
Laboratory investigations in Mechanics, Thermal Physics, Optics, Quantum, Electricity and Magnetism. Techniques of statistics and data analysis, library and literature research, computer interfacing and simulation are explored. One hour per week plus two laboratories. *Prerequisite: PHYS 20200 and one of the following: PHYS 30100, 30200, or 30400. Annually. Spring.*

PHYS 41000. INTERNSHIP
A structured, usually off-campus experience, in which a student extends classroom knowledge to a work position within a community, business, or governmental organization. Student interns work and learn under the joint guidance of a host organization supervisor and a College of Wooster mentor. The student must arrange the internship in advance through the appropriate department or program. No more than six internships, and a maximum of four Wooster course credits, will count toward graduation. The form for registering for an internship and the Internship Learning Plan are available in the office of the Registrar. *(0.25-4 course credits) S/NC course. Prerequisite: The approval of a College of Wooster mentor, department chair, the faculty adviser, and the Associate Dean for Experiential Learning is required. Annually.*

PHYS 45100. INDEPENDENT STUDY THESIS – SEMESTER ONE
The first semester of the Senior Independent Study project, in which each student engages in creative and independent research guided by a faculty mentor and which culminates in a thesis and an oral examination in the second semester. *Prerequisite: PHYS 40100.*

PHYS 45200. INDEPENDENT STUDY THESIS – SEMESTER TWO
The second semester of the Senior Independent Study project, which culminates in the thesis and an oral examination. *Prerequisite: PHYS 45100.*