PHYSICS (PHYS)

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Physics is the study of how the universe works. From the smallest of sub-atomic particles to the largest clusters of galaxies, physicists try to take apart the pieces of reality and observe how they fit together. When a piece of the puzzle fits into place in your understanding, the world around you looks different. From this understanding, one can see more clearly the dance of nature and the rules that govern it.

Physics students at Guilford come from a variety of backgrounds and have a broad spectrum of interests and career goals. About one- third of our physics majors plan for employment in a technical field immediately after graduation. Another third pursue graduate study in physics or astronomy. The remaining third go on to advanced study in another field. The common thread connecting the different goals and focuses of our students and faculty is the physicist's approach to thinking about, modeling and understanding the universe. This process relies on clear, analytical and often abstract thinking but is ultimately grounded in concrete reality as exposed by experiment. These skills are of value in not only science and engineering but also business, law, medicine and many other endeavors.

To embrace the diverse interests of our student population, the physics curriculum is flexible and personalized. We emphasize research and experimentation throughout our program, allowing students to follow their interests. In introductory courses, students learn to work with equipment, quantify experimental uncertainties and hone their scientific writing. The experimental physics sequence stresses laboratory techniques, cooperative research, and clear, thoughtful presentation of results. In this sequence of courses, students design experiments, act as principal investigators, write journal articles and give talks for peer review. In short, they learn how to perform self-directed research. This research experience culminates in a thesis project that must be original and designed by the student. The program thus provides a coherent developmental process that gives students the skills they need to succeed.

Degree Offered

The Bachelor of Arts and Bachelor of Science degrees are offered in physics.

***Note**: PHYS 101 Physics for Nonscientists (variable title)., PHYS 104 Elementary Electronics (CTIS 104), PHYS 107 The Solar System, PHYS 108 Realm of the Stars, and PHYS 109 Beyond the Stars do not apply toward major or minor.*

Scholarships and Research Awards

To recognize superior work in physics, the department annually offers the E. Garness Purdom Scholarship to a rising senior physics major. The department also offers three awards to support student research – the Michael Jeglinski Physics Award, the Winslow Womack Research Award and the Adelberger Research Award. Physics majors also are eligible for the Glaxo-Wellcome Women in Science Scholarship, awarded annually to an outstanding rising junior woman science major, and the E.G. Purdom Memorial Award for Women in Physical Science.

https://catalog.guilford.edu/catalog/academic-resources/frank-family-science-center/

Physics

The physics curriculum helps students to learn the science of physics and become critical empirical thinkers. To accomplish these goals, the Department of Physics emphasizes undergraduate research – especially projects initiated and designed by students – as a critical element in the physics learning process. Beginning in the first year, students are asked to initiate and design their own investigations. More than 3,000 square feet of laboratory space within the department supports undergraduate research. Many of the experiments that students conduct here are independent projects that are not associated with any particular course. Equipment for these experiments is constructed and modified in the shop facilities in the basement of the Frank Family Science Center.

The department offers three endowed physics awards, the Adelberger Award, in memory of Prof. Rex Adelberger, the Jeglinski Physics Award, in memory of Boleslaw Jeglinksi and Michael Jeglinski, and the Helen and Winslow Womack Physics Research Award. These awards are given annually to students to support their research and fund their travel to professional scientific meetings such as the National Conference on Undergraduate Research.

The department's introductory laboratories rely on a microcomputer-based data gathering and analysis system. The advanced laboratories, created with support from the National Science Foundation, focus on experimental modern physics and include cryogenics, optics, atomic and nuclear physics, electronics centers and astronomical observing tools. Students learn to control the sophisticated equipment in these centers using LabVIEW™ and Python programs.

In addition to the laboratory space, the department houses two rooms of student office space. Each physics major is given a desk and may use this space as a place to study and store books. These rooms, provided by gifts from the physics alumni, are both personal and community space, for collaboration and forging connections.

Observatory

The Frank Family Science Center houses the J. Donald Cline Observatory and an astronomy lab, a photographic darkroom and an observatory support room. The principal instruments are an automated robotic 16-inch Ritchey-Chretien telescope, a 10-inch telescope, four 8-inch telescopes, and a two-inch H-alpha telescope for solar viewing. Instrumentation for the optical telescopes includes CCD and DSLR cameras, photometers, and spectrometers. This facility is used in the introductory astronomy and physics classes, for public viewing and for undergraduate student research. The College also shares access to a research-grade 32-inch telescope at the Three College Observatory that is located about 33 miles from campus.

https://catalog.guilford.edu/catalog/graduation-requirements-programs-offered/

Engineering

Do you want to be an engineer with a solid foundation in the liberal arts and excellent oral and written communication skills? The Guilford physics program may be just the right one for you. At Guilford, students learn how to attack and solve complicated problems by getting to the root causes and analyzing connections between the pieces. In addition, Guilford physics students become excellent communicators to both technical and non-technical audiences. These are critical skills for a successful engineer. More than 30 percent of Guilford physics graduates have careers in engineering or engineering-related fields, and they all say that the skills they learned in Guilford Physics have been essential in preparing them to be better engineers. At Guilford, these students concentrated on applied physics while also benefiting from our strong writing program and broad liberal arts education. Guilford-trained engineers are not only excellent in finding technical solutions to problems, they understand the relationship between technology and humankind and can communicate effectively with people of diverse cultural backgrounds and technical knowledge. The training in alternate perspectives that a liberal arts education provides will be a critical asset for 21st-century engineers who will need to navigate through complicated problems and find creative solutions. The Guilford Physics program is highly flexible and individualized, and you can chart your own path through the courses to provide yourself with just the right preparation you need for your future engineering goals.

- Physics Major (https://catalog.guilford.edu/catalog/academic-departments-majors/physics/physics/)
- Physics Minor (https://catalog.guilford.edu/catalog/academic-departments-majors/physics/physics-minor/)

PHYS 101. Physics for Nonscientists (variable title).. 4.
Introductory course, intended for students with limited mathematical background and centered on one of several topics such as an in-depth look at the physics of energy or a survey of modern physical thought. The relevance of physical laws to both society and the environment is discussed. Fulfills natural science/mathematics requirement (1998 & 2019).

PHYS 104. Elementary Electronics (CTIS 104). 4.
Introduces students to the behavior of the fundamental building blocks of modern electronic devices and the underlying scientific principles that make these devices work. Topics will be derived from analog and digital electronics and include resistance, capacitance, diodes, signal filtering, positive and negative feedback, operational amplifiers, Boolean logic, logic gates, and digital to analog conversion. This course is designed for the general student population (but not physics majors and physics minors) who are interested in exploring the fundamentals of electronics. Prerequisite: Successful completion of the quantitative literacy requirement. Spring. Fulfills natural science/mathematics requirement (1998 2019). Offered in alternate years.

PHYS 107. The Solar System. 4.
This course covers the physical description of the planets, their satellites, the sun, asteroids and comets, with a strong emphasis on recent information from landers and fly-by probes. This course includes discussions of how science is known, learned and taught, which will be of interest to future teachers and others who may wish to combine work with students and science. Fulfills natural science/mathematics requirement (1998 & 2019).

PHYS 108. Realm of the Stars. 4.
Concentrates on the study of stars. Topics include stellar observation and the life, evolution and death of stars. Fulfills natural science/mathematics requirement (1998 & 2019).

PHYS 109. Beyond the Stars. 4.
Concentrates on the study of extra-galactic astronomy. Topics include nebulae, galaxies and cosmology. Fulfills natural science/mathematics requirement (1998 & 2019). Numeric/symbolic engagement requirement (2019).

PHYS 111. Introduction to Physics for the Life Sciences I. 4.
The laws of physics describe the constraints and possibilities within which living organisms must thrive. Organisms must support themselves against gravity, must move through fluids, and must manage the thermodynamics of energy production and consumption. A thorough understanding of the tools and concepts of physics can undergird a richer understanding of the properties and processes of life and the technologies we use for research and medicine. This course will embed the ideas and modeling skills of physics in a rich biological and medical context, emphasizing analytic skills, modelling and problem-solving.

PHYS 112. Introduction to Physics for the Life Sciences II. 4.
The laws of physics describe the constraints and possibilities within which living organisms must thrive. Organisms must support themselves against gravity, must move through fluids, and must manage the thermodynamics of energy production and consumption. A thorough understanding of the tools and concepts of physics can undergird a richer understanding of the properties and processes of life and the technologies we use for research and medicine. This course will embed the ideas and modelling skills of physics in a rich biological and medical context, emphasizing analytic skills, modelling and problem- solving.
Prerequisite: PHYS 111.

PHYS 114. Introduction to Electronics for Scientists. 4.
4. Introduces students to the behavior of the fundamental building blocks of modern electronic devices and the underlying scientific principles that make these devices work. Topics will be derived from analog and digital electronics and include resistance, capacitance, diodes, signal filtering, positive and negative feedback, operational amplifiers, Boolean logic, logic gates, and digital to analog conversion. This course is designed for students majoring or minoring in physics and is also appropriate for other math and science students with good quantitative skills who are interested in exploring the fundamentals of electronics.
Prerequisite: any one of the following courses: CHEM 111, MATH 121, MATH 123, PHYS 112, PHYS 117, PHYS 121 or instructor permission. Spring. Fulfills natural science/mathematics requirement (1998 2019). Offered in alternate years.

PHYS 121. Classical and Modern Physics I. 4.
For physics majors and others interested in physics. This course is not a survey but an introduction to the thinking and analysis processes of physics, with classroom and laboratory topics chosen from modern and classical physics to emphasize the skills needed to think like a physicist. Corequisite: Math 220 or instructor permission. Fulfills natural science/mathematics requirement. Spring.

PHYS 122. Classical and Modern Physics II. 4.
For physics majors and others interested in physics. This course is not a survey but an introduction to the thinking and analysis processes of physics, with classroom and laboratory topics chosen from modern and classical physics to emphasize the skills needed to think like a physicist. Prerequisite: PHYS 121 and MATH 220. Corequisite: PHYS 480 strongly recommended. Fulfills natural science and mathematics requirement. Spring.

PHYS 131. Experimental Expl. of Physics. 1-4.
Project-based introduction to experimental design, hypothesis testing, and data analysis. Students will develop guided inquiry questions and design experiments to test their hypotheses. (1)

PHYS 132. Intro. to Experimentation. 3-4.

PHYS 150. Special Topics. 8.
May also be offered at 250, 350 and 450 levels.

PHYS 204. Electronics. 4.
Introduces students to the behavior of the fundamental building blocks of modern electronic devices and the underlying scientific principles that make these devices work. Topics will be derived from analog and digital electronics and include resistance, capacitance, diodes, signal filtering, positive and negative feedback, operational amplifiers, Boolean logic,logic gates, and digital to analog conversion. This course is designed for students majoring or minoring in physics and those other students who have completed an introductory calculus-based course in electricity and magnetism and are interested in applying this background to electronics. Prerequisite: PHYS 223 or instructor permission. Spring. Corequisite: PHYS 480 strongly recommended. Fulfills natural science/mathematics requirement (1998 2019). Offered in alternate years.

PHYS 210. Observatory Practice. 4.
For physics majors and others interested in learning to use the J. Donald Cline Observatory at Guilford. The course includes astronomical background drawn from solar system, stellar and extra-galactic astronomy but the emphasis is on the use of the equipment, methods of data acquisition and analysis of results. . Fulfills natural science/ mathematics requirement (1998 & 2019).

PHYS 211. College Physics I. 4.
For science majors and other interested students whose mathematics background includes algebra and trigonometry. This sequence includes survey of physics with topics chosen from mechanics, energy, thermodynamics, electricity and magnetism, optics, wave motion, and modern physics. Algebra and trigonometry required which do not need not be on the college level. Sequence begins each fall. Fulfills the natural science/mathematics requirement (1998 & 2019). Numeric/symbolic engagement requirement (2019). Fall.

PHYS 212. College Physics II. 4.
For science majors and other interested students whose mathematics background includes algebra and trigonometry. This sequence includes survey of physics with topics chosen from mechanics, energy, thermodynamics, electricity and magnetism, optics, wave motion, and modern physics. Sequence begins each fall.
Prerequisite: PHYS 211 or instructor permission. Fulfills the natural science/mathematics requirement (1998 2019). Numeric/symbolic engagement requirement (2019). Spring.

PHYS 220. Introduction to Machine Learning. 4.
More and more interactions in our lives are being shaped by so-called artificial intelligences. These computer programs have grown in sophistication to the point where they can classify and respond to complicated enough inputs such that their reactions can seem to indicate intelligent decision-making. In almost every field of inquiry or work, we are being surrounded by clouds of enormous data sets, and it is getting impossible for any human to be able to parse through the data and identify either patterns or interesting exceptions. This three-week, project-based course aims to give non-science students a sense of what machine learners do, what kinds of machine learning tools are out there, and how to choose what type of tool to use to handle a range of problems.

PHYS 223. Classical and Modern Physics III. 4.
The final semester of the introductory physics sequence. Topics are chosen from modern and classical physics to complement those discussed in PHYS 121.
Prerequisite: PHYS 122 or instructor permission. Corequisite: PHYS 480 strongly recommended. Fall.

PHYS 224. Classical & Modern Physics IV. 4.
The thermal properties of matter are studied from the applied approach of thermodynamics and the theoretical analysis of statistical mechanics. Topics include the laws of thermodynamics, equations of state, first order phase transitions, partition functions, entropy and the quantum statistics of particles.
Prerequisite: MATH 224, PHYS 223 or instructor permission. Corequisite: PHYS 480 strongly recommended. Spring.

PHYS 231. Experimental Physics I. 2.
Intermediate-level laboratory course to develop experimental design and measurement techniques, data reduction and analysis methods, and oral and written presentation skills. Experiments vary as equipment and technologies evolve. Prerequisite PHYS 122 or instructor permission. Fall.

PHYS 232. Experimental Physics II. 2-4.
Intermediate-level laboratory course to develop experimental design and measurement techniques, data reduction and analysis methods, and oral and written presentation skills. Experiments vary as equipment and technologies evolve.
Prerequisite: PHYS 121 or instructor permission. Spring.

PHYS 241. Scientific Computing (MATH 241). 4.
Scientific Computing is a course designed jointly by Math & Physics faculty to serve students of the sciences. We will use spreadsheets (Excel, Numbers, Sheets) to analyze data using formula computation and representational graphics. We will use the programming language Python and a variety of the standard libraries (especially numpy,matplotlib, vpython) to do similar analyses and complex simulations. We will emphasize the documentation and presentation of results to peers. The course is to betaught in the three week ?Prolog Term? of the Fall Semester..

PHYS 250. Special Topics. 8.

PHYS 260. Independent Study. 1-8.
May also be offered at 360 and 460 levels.

PHYS 290. Internship. 1-8.
May also be offered at the 390 level.

PHYS 320. Mathematical Physics (MATH 320). 4.
4. Introduces students to mathematical techniques of particular importance to scientists and engineers. Topics include: complex numbers, Fourier series and the solution of differential equations (with special emphasis on harmonic oscillators). Both analytical and numerical methods are studied.
Prerequisite: MATH 225 or instructor permission; PHYS 122 strongly recommended. Corequisite: PHYS 480 strongly recommended. Spring. Fulfills quantitative literacy requirement.

PHYS 350. Special Topics. 1-8.

PHYS 360. Independent Study. 1-8.

PHYS 370. Physics Research. 1-4.
The presentation of independent research projects completed during summers (e.g. the National Science Foundation-sponsored Research Experience for Undergraduates) or industrial internships. Students who are unable to undertake research at other institutions may design and complete their research on campus under the guidance of Guilford faculty.

PHYS 390. Internship. 1-8.

PHYS 421. Mechanics. 4.
The study of forces and energy and their effect on the motion of particles. Topics include the motion of a particle in a force field, the dynamics of rigid bodies, and the detailed study of damped, forced and coupled oscillators. Newtonian and Lagrangian formulation of mechanics as well as computational methods of solution will be studied.
Prerequisite: PHYS 223 and MATH 226 or instructor permission. Offered in alternate years.

PHYS 422. Electromagnetism. 4.
The study of the theory of electric and magnetic fields and their interactions with matter. Topics include the use of vector calculus, Gauss?s law, Ampere?s law, diamagnetism, multi-pole fields and the law of Biot-Savart.
Prerequisite: PHYS 223 and MATH 226 or instructor permission. Offered in alternate years.

PHYS 423. Quantum Mechanics. 4.
The study of the theory of the interaction of particles, waves and fields in atomic and subatomic systems. Topics include the Schrodinger formulation, operator formalism and perturbation theory.
Prerequisite: PHYS 223 and MATH 226 or instructor permission. Offered in alternate years.

PHYS 441. Advanced Modern Physics. 4.
Topics in applied modern physics including the hydrogen atom and other atomic systems, nuclear physics, condensed matter and elementary particles.
Prerequisite: PHYS 223 and MATH 226 or permission of the instructor. Offered in alternate years.

PHYS 442. Advanced Classical Physics. 4.
Advanced topics in classical mechanics and electromagnetism. Topics may include Hamiltonian mechanics, motions of particles in non-inertial reference frames, the Maxwell equations, electromagnetic radiation and the dynamics of relativistic particles and electromagnetic fields.
Prerequisite: PHYS 421, PHYS 422 and MATH 226 or instructor permission. Offered based upon demand.

PHYS 443. Astrophysics. 2-4.
The study of the application of physics to astronomical systems. Topics may include stellar structure and evolution, energy generation and nucleosynthesis, the interstellar medium, radiative transfer and degenerate stars.
Prerequisite: instructor permission. Offered based upon demand.

PHYS 450. Special Topics. 1-8.

PHYS 460. Independent Study. 1-8.

PHYS 461. Physics Research Seminar. 1.
All students writing theses or doing other research within the physics department are required to take this course in which students and faculty exchange suggestions, ideas and insights into their research. Fall and spring. CR/NC. Students may take this course more than once and may count up to 4 credits of Physics Research Seminar toward graduation.

PHYS 470. Research, Thesis and Defense. 1-8.
Independent research projects that culminate, with guidance, in a well-defined research thesis. The thesis must be presented both orally and in writing. The thesis should be written in the standard form for technical papers in physics as currently set forth in Volume 10 of the Journal of Undergraduate Research in Physics. Students are encouraged to present their papers at NCUR or another appropriate conference. Fall and spring.

PHYS 480. Physics Department Seminar. 0.
All students taking PHYS 121 or above are required to attend the Physics Department Seminar. During the semester, each student will give presentations on some aspect of the physics work on which he or she is currently working. Fall and spring.

PHYS 490. Honors Research, Thesis and Defense. 1-8.
Although enrollment is normally during the fall of the final year, the student is expected to begin work during the intermediate years on independent research projects that will culminate, with guidance, in a well- defined research thesis. The thesis must be presented both orally and in writing. The thesis should be written in the standard form for technical papers in physics as currently set forth in Volume 10 of the Journal of Undergraduate Research in Physics. Students are encouraged to present their papers at NCUR or another appropriate conference.