Physics and Astronomy

Website: physics.sewanee.edu

The Department of Physics and Astronomy provides a variety of stimulating opportunities to learn about the world around us: from everyday phenomena and modern-day technologies, through the vastness of outer space and minuteness of the nano-realm, to the bizarre quantum-relativistic fabric of physical reality. Fueled by curiosity and dedicated to excellence in teaching and research, Sewanee's physics and astronomy faculty often involve like-minded students in their diverse scholarly pursuits, which include hunting for asteroids and extrasolar planets; nuclear and accelerator physics; biophysics; materials characterization; simulation, fabrication, and optical studies of functional nanomaterials.

At The University of the South, a focused physics education fits naturally within the liberal arts and sciences environment that forms the core of the Sewanee experience. Students who take our physics and astronomy courses develop a robust understanding of fundamental physical principles—the essence of "how the world works"—as well as valuable reasoning, problem-solving, and experimentation skills. Our physics majors also delve into advanced theoretical topics, utilize research-grade instrumentation and data analysis tools, participate in faculty-led and independent research projects, both on campus and at other institutions, presenting their findings at department seminars and national conferences.

University Observatory

The Cordell-Lorenz Observatory is an instructional laboratory for astronomy courses offered by the department of physics and astronomy and also for public observations. Programs throughout the year and open hours every Thursday evening from 8 p.m. until 10 p.m. (weather permitting), while classes are in session, encourage both academic and enrichment activities.

The largest telescope for public observations is a ten-inch Schmidt-Newtonian reflector. There are also other ten-inch and one three and one-half-inch telescopes which are often used, as well as large binoculars. The dome houses a classic six-inch refracting telescope crafted by Alvan Clark and Sons in 1897. It has been restored to its original quality and historical appearance by Dr. Francis M. Cordell Sr. of the Barnard Astronomical Society.

For research purposes, one 0.35 and five 0.30 meter (14 and 12 inches) telescopes on computer controlled mounts are housed in several small roll-off sheds on the roof of Carnegie. These telescopes have sensitive CCD detectors which are used to monitor newly discovered asteroids, comets, supernovas, gamma ray bursts, and variable stars.

Faculty

Associate Professor M. Coffey

Assistant Professor Donev

Professors Durig (Chair), Peterson, Szapiro

Major

Requirements for the Major in Physics

The physics major requires successful completion of one of the following tracks:

Intensive Track

The intensive track is for students who intend to pursue graduate work in the physical sciences. Research participation and laboratory assistantships are encouraged.

Course Requirements [1]		
CHEM 101		4
CHEM 102		4
MATH 207	Multidimensional Calculus	4
MATH 212	Differential Equations	4
PHYS 305	Advanced Laboratory	4
Select eight lecture courses in physics (PHYS)		32
Select two seminars (PHYS 312)		4
Total Semester Hours		**56**

Additional Requirements

A comprehensive examination [2]	

1 Please note that the knowledge and skills acquired in PHYS 101, PHYS 102 or PHYS 103, PHYS 104 are presumed for any upper level physics course except for PHYS 250 and PHYS 251.

2 The Graduate Record Examination (GRE) is required as part of the comprehensive examination.

Broad Track

The broad track is for students who intend to pursue graduate work in medicine, engineering, biophysics, environmental sciences, health physics, or teaching. Research participation and laboratory assistantships are encouraged.

Course Requirements [1]		
PHYS 203	Intermediate Electricity and Magnetism I	4
PHYS 303	Mechanics	4
PHYS 305	Advanced Laboratory	4
PHYS 307	Introduction to Modern Physics I	4
Select three lecture courses in physics (PHYS)		12
Select two seminars (PHYS 312)		4
Select five additional courses in science or mathematics approved by the physics department		20
Total Semester Hours		**52**

Additional Requirements
A comprehensive examination

1 Please note that the knowledge and skills acquired in PHYS 101, PHYS 102 or PHYS 103, PHYS 104 are presumed for any upper level physics course except for PHYS 250 and PHYS 251.

Pre-engineering Track

The pre-engineering track is for students who intend to pursue engineering. Research participation and laboratory assistantships are encouraged.

Course Requirements [1]		
CHEM 101		4
CHEM 102		4
CSCI 157	Introduction to Modeling and Programming	4
MATH 207	Multidimensional Calculus	4
MATH 212	Differential Equations	4
PHYS 203	Intermediate Electricity and Magnetism I	4
PHYS 303	Mechanics	4
Select four lecture/laboratory courses in physics (PHYS)		16
Select one seminar (PHYS 312)		2
Total Semester Hours		**46**

Additional Requirements
A comprehensive examination

1 Please note that the knowledge and skills acquired in PHYS 101, PHYS 102 or PHYS 103, PHYS 104 are presumed for any upper level physics course except for PHYS 250 and PHYS 251.

Course Sequencing

For a first-year student planning to major in physics, the following curriculum is recommended. The second-year program should be planned in consultation with the department chair. Students may seek advanced placement in physics, mathematics, and foreign language.

Course Requirements		
PHYS 103	Modern Mechanics (Lab)	4
PHYS 104	Electric and Magnetic Interactions (Lab)	4

HUMN 103	Experience, Expression, and Exchange in Western Culture: Texts and Contexts of the Ancient World	4
HUMN 104	Experience, Expression, and Exchange: Texts and Contexts of the Medieval to Early Modern Worlds	4
MATH 101	Calculus I	4
MATH 102	Calculus II	4
Foreign Language 103, 104		8
Physical Education		

Minor

Requirements for the Minor in Physics and Astronomy

The minor requires successful completion of the following:

Course Requirements [1,2]		
PHYS 250	Solar System Astronomy (Lab)	4
PHYS 251	Stellar and Galactic Astronomy (Lab)	4
PHYS 444	Independent Study [3]	2
Select one of the following: [4]		8
PHYS 201 and GEOL 121	Optics and Physical Geology (Lab)	
PHYS 303 and PHYS 304	Mechanics and Theoretical Mechanics	
PHYS 307 and PHYS 308	Introduction to Modern Physics I and Introduction to Modern Physics II	
Total Semester Hours		**18**

1. Please note that the knowledge and skills acquired in PHYS 101, PHYS 102 or PHYS 103, PHYS 104 are presumed for any upper level physics course except for PHYS 250 and PHYS 251.
2. An average grade of at least C is required for completion of the minor.
3. The comprehensive examination is not required, but each student must present the results of the PHYS 444 project during a seminar.
4. PHYS 349 may be substituted for one of the advanced physics courses.

Courses

Physics and Astronomy Courses

The knowledge and skills acquired in PHYS 101, PHYS 102 or PHYS 103, PHYS 104 are presumed for any upper level physics course except for PHYS 250 and PHYS 251.

PHYS 101 General Physics I (Lab) (4)
This broad study of classical and modern physics includes all major fields. The mathematical description utilizes geometry, trigonometry, algebra and calculus. Lectures: three hours; laboratory, three hours.

PHYS 102 General Physics II (Lab) (4)
This broad study of classical and modern physics includes all major fields. The mathematical description utilizes geometry, trigonometry, algebra and calculus. Lectures: three hours; laboratory, three hours. *Prerequisite: PHYS 101.*

PHYS 103 Modern Mechanics (Lab) (4)
This course begins with the conservation of momentum and energy. It deals with energy and gravitational interactions, and emphasizes the atomic structure of matter, and the modeling of materials as particles connected by springs. The course is designed for engineering and science students. The main goal of this course, which is formatted with an integrated lab-lecture (studio) approach, is to have the students engage in a process central to science-the attempt to model a broad range of physical phenomena using a small set of powerful fundamental principles. The course counts in fulfillment of the general distribution requirement for a laboratory science course. The course is not open for credit to students who have earned credit for PHYS 101. *Open only to new first-year students and first-year students.*

PHYS 104 Electric and Magnetic Interactions (Lab) (4)
This course deals with electric and magnetic fields. The main goal of this course, which is formatted with an integrated lab-lecture (studio) approach, is to have the students engage in a process central to science-the attempt to model a broad range of physical phenomena using a small set of powerful fundamental principles. The course is designed for engineering and science students. The course counts in fulfillment of the general distribution requirement for a laboratory science course. The course is not open for credit to students who have earned credit for PHYS 102. *Open only to new first-year students. Prerequisite: PHYS 103.*

PHYS 105 Energy and the Environment (4)
This course examines the various energy sources currently being used in our society and those proposed for future use. The fundamental physical principles underlying the production, transmission and use of these sources are studied. Particular application is made to the analysis of local energy production and usage.

PHYS 106 Foundations of Global Warming (4)
A study of the physical principles and mechanisms underlying global warming. Influences of the sun, earth surface, atmosphere, and oceans are considered. Observational records that describe surface temperatures and changes in the gaseous atmosphere are examined. Also discussed are effects of global warming and possible future scenarios.

PHYS 110 Our Place in the Universe: An Introduction to the Science of Astronomy (4)
A consideration of how planet Earth fits into its solar system, its galaxy, and the larger cosmos. Evening sessions will allow observations of asteroids, comets, galaxies, novae, supernovae and gamma ray bursts. The course includes image analysis for scientific data. A student may not receive credit for PHYS 149 or PHYS 250 after completing this course or for this course if either of those has been taken. Four meetings per week. *Open only to new first-year students and first-year students.*

PHYS 111 How Things Work (4)
The course offers a non-conventional view of science that starts with objects of everyday experience and looks inside them to explore what makes them work. It is designed to help liberal arts students establish a connection between science and their world, bringing science to students rather than the reverse. Students work in cooperative learning groups and present a final project focused on a device or process of their interest. *Open only to new first-year students and first-year students.*

PHYS 120 The Science of Music (4)
An introductory course on musical acoustics which includes the principles of sound production, propagation, and perception through inquiry-based methods. The ways in which different sounds are produced are explored through experimentation with both existing and student-constructed instruments (e.g., string, woodwind, brass, percussion). Modern digital music technologies and concepts are also introduced as well as issues related to room and concert hall acoustics. *Open only to new first-year students and first-year students.*

PHYS 123 Introduction to Fractals and Chaos (4)
A study of the beauty and generality of nonlinear processes, from the point of view of fractals and chaos. Examples from art, economics, medicine, history, and traditional sciences will be explored through demonstrations and models. This is a one semester, non-laboratory course.

PHYS 149 Survey of Astronomy (4)
A one-semester, non-laboratory course intended for non-science majors. The topics covered include history of astronomy, physics of astronomy, and current developments in this dynamic field. There is an out-of-class assignment to visit the Cordell-Lorenz Observatory for a two-hour observing session three times during the semester during clear nights more than five days away from the Full Moon.

PHYS 201 Optics (4)
A study of the fundamental principles of geometrical and physical optics with lasers and holography used extensively in the laboratory. Lecture, three hours.

PHYS 202 Thermodynamics (4)
Classical thermodynamics theory with applications and an introduction to statistical mechanics. Lecture, three hours.

PHYS 203 Intermediate Electricity and Magnetism I (4)
The electric and magnetic fields produced by simple charge and current distributions are calculated. Alternating and direct-current circuits with passive and active components are tested.

PHYS 204 Intermediate Electricity and Magnetism II (4)
The electric and magnetic fields produced by simple charge and current distributions are calculated. Alternating and direct-current circuits with passive and active components are tested. *Prerequisite: PHYS 203.*

PHYS 250 Solar System Astronomy (Lab) (4)
A study of the development of astronomy from ancient to modern times with special emphasis on the solar system-in particular to mathematical and physical models used in describing it. No prerequisites. Open to all students but designed to meet the needs and abilities of a science major. Satisfies the physical science requirement. Cannot be taken for credit if PHYS 149 has been completed. Lecture, three hours; laboratory in the Observatory.

PHYS 251 Stellar and Galactic Astronomy (Lab) (4)
Stellar and galactic astronomy. Comparisons and tests of physical models applied to astronomy using photographically obtained data, and the limitations of this tool as a method of analysis will be stressed in the accompanying laboratory. Lecture, three hours; laboratory, three hours.

PHYS 303 Mechanics (4)
A required course for physics majors and most engineering students. Mathematical methods are emphasized. Lecture, three hours.

PHYS 304 Theoretical Mechanics (4)
Moving coordinate systems, rigid-body dynamics, Lagrangian mechanics, and variational principles. *Prerequisite: PHYS 303.*

PHYS 305 Advanced Laboratory (2)
This course offers an introduction to the theory and practice of experimental physics, with an emphasis on modern experiments and techniques. Experimental topics can include spectroscopy from gamma energies into the infrared, NMR, visible and infrared optics, holography and diffractive optics, scanning electron microscopy, and advanced electronics with computer interfacing. Some experiments are performed offsite to use instruments not available on campus. Programming languages such as LabVIEW, MatLab, and Mathematica are used. Attendance at departmental seminars is required. May be repeated for credit up to a total of 8 hours. *Prerequisite or Corequisite: PHYS 203.*

PHYS 307 Introduction to Modern Physics I (4)
Surveys important developments in physics during the twentieth century, including general and special relativity, superconductivity, quantum theory and its applications to the description of the atomic and subatomic world. Lecture, three hours.

PHYS 308 Introduction to Modern Physics II (4)
Surveys important developments in physics during the twentieth century, including general and special relativity, superconductivity, quantum theory and its applications to the description of the atomic and subatomic world. Lecture, three hours. *Prerequisite: PHYS 307.*

PHYS 312 Junior Seminar (2)
A series of lectures by faculty, students, and invited speakers. Every student is expected to present at least one talk on a topic of his or her choice in physics. The public is invited.

PHYS 349 Readings in Cosmology (4)
A course for those with some background in physics or astronomy who are interested in the origin and structure of our universe. Readings include Stephen Hawking's *A Brief History of Time* and other modern texts, in addition to historical cosmology tests such as Aristotle's *On the Heavens* or Galileo's *Dialogue Concerning the Two Chief World Systems*. Writing assignments include two papers—˜one of these on non-western cosmology—˜and a class project involving observation of a supernova or gamma ray burst. *Prerequisite: PHYS 101 or PHYS 102 or PHYS 103 or PHYS 104 or PHYS 110 or PHYS 149 or PHYS 250 or PHYS 251.*

PHYS 401 Quantum Mechanics (4)
The mathematical formalism of quantum mechanics is developed and applied to potential wells, the harmonic oscillator, and the hydrogen atom. Dirac notation is introduced and used in the description of angular momentum and electron spin.

PHYS 407 Physics Research I and Modern Physics (2 or 4)
An introduction to research in physics through theoretical and experimental investigation of an original problem. Reporting research work at seminars and professional meetings is encouraged.

PHYS 408 Physics Research II (2 or 4)
An introduction to research in physics through theoretical and experimental investigation of an original problem. Reporting research work at seminars and professional meetings is encouraged.

PHYS 410 Mathematical Methods in Physics (4)
Vector spaces and linear operators, with applications. Fourier series, boundary value problems, orthogonal functions.

PHYS 412 Senior Seminar (2)
A series of lectures by faculty, students and invited speakers. Every student is expected to present at least one talk on a topic of his or her choice in physics. The public is invited. *Prerequisite: PHYS 312.*

PHYS 421 Advanced Electromagnetic Theory (4)
Boundary-value problems in rectangular, spherical, and cylindrical coordinates are discussed. The solutions of the wave equation for conducting and non-conducting media are applied to selected topics in optics and plasma physics. *Prerequisite: MATH 212 and PHYS 204.*

PHYS 444 Independent Study (2 or 4)
For selected students. *Prerequisite: Professor consent and prerequisite override required.*