PHYSICS

Program Description

Physics is the most fundamental science and underlies our understanding of nearly all areas of science and technology. In a broad sense, physics is concerned with the study of energy, space, and matter, and with the interactions between matter and the laws that govern these interactions. More specifically, physicists study mechanics, heat, light, electric and magnetic fields, gravitation, relativity, atomic and nuclear physics, and condensed matter physics.

Approximately 40 percent of the graduating physics majors from Sacramento State continue on to graduate school earning advanced degrees in Physics, Mathematics, Engineering, Environmental Science, Medicine, or Business. Another 50 percent find job opportunities in industrial and government laboratories or agencies. The remaining 10 percent obtain their teaching credential.

Degree Programs

BA in Physics (http://catalog.csus.edu/colleges/natural-sciences-mathematics/physics-astronomy-physical-science/physics/ba-in-physics/)

BA in Physics (Teacher Preparation) (http://catalog.csus.edu/colleges/natural-sciences-mathematics/physics-astronomy-physical-science/physics/ba-in-physics-teacher-preparation/)

BS in Physics (http://catalog.csus.edu/colleges/natural-sciences-mathematics/physics-astronomy-physical-science/physics/bs-in-physics/)

BS in Physics (Applied Physics) (http://catalog.csus.edu/colleges/natural-sciences-mathematics/physics-astronomy-physical-science/physics/bs-in-physics-applied-physics/)

Minor in Physics (http://catalog.csus.edu/colleges/natural-sciences-mathematics/physics-astronomy-physical-science/physics/minor-in-physics/)

Certificate in Scientific Computing and Simulation (http://catalog.csus.edu/colleges/natural-sciences-mathematics/physics-astronomy-physical-science/physics/certificate-in-scientific-computing-and-simulation/)

Certificate in Scientific Instrument Development (http://catalog.csus.edu/colleges/natural-sciences-mathematics/physics-astronomy-physical-science/physics/certificate-in-scientific-instrument-development/)

Special Features

- In addition to providing a broad academic background and facility in analytic thinking, the study of physics fosters and emphasizes independent study experiences. Most physics students at Sacramento State typically spend a year working on a Senior Project, often in conjunction with a faculty member. These independent projects not only provide a vehicle for applying material learned in class and give students experience in electronics, measurement systems, computers, and machine shop work, but also teach students to work and think on their own. Faculty in the Department have been active in research in atomic physics, astrophysics, biophysics, condensed matter physics, high energy physics, instrumentation, liquid crystals, low temperature physics, optics, and physics education research.
- An advising system has been established by the Department of Physics and Astronomy to help students plan their schedules each semester, to discuss independent project possibilities, and to provide career and current job information. Because of the large number of sequential courses in the degree programs, the Department requires that each student contact his/her advisor before registering for classes each semester. Any student without an advisor should contact Professor William DeGraffenreid in Sequoia Hall 230, or call (916) 278-6518.

Career Possibilities

A degree in physics will prepare you for a wide range of careers. The advanced problem solving, technical, and communication skills one develops alongside the physics knowledge in our degrees are highly valued by many industries. Recent graduates from our programs have an extremely diverse range of careers including: faculty members at colleges and universities, employees at National and State Laboratories and Agencies, teachers at middle and high school, engineers, scientific technicians, analysts, technical writers, computer programmers, and science policy.

Contact Information

Christopher Taylor, Department Chair
Heidi Yamazaki, Administrative Support Coordinator
Sequoia Hall 230
(916) 278-6518
Department of Physics and Astronomy (http://www.csus.edu/physics/)

Faculty

BARNIOL DURAN, RODOLFO

BLOCK, MATTHEW

BUERKI, JEROME

DEGRAFFENREID, WILLIAM C.

JENSEN, MIKKEL

MARGONINER, VERA

MORRIS, ELIZA

MOSS, JOSHUA

PETTITT, ALEXANDER

RAY, MICHAEL

SANTANGELO, BRIANNA

SERGAN, VASSILI V.

SERGAN, TATIANA

TASHIRO, LYNN

TAYLOR, CHRISTOPHER L.

PHYS 1. Physical Reasoning and Calculation. 2 Units
Term Typically Offered: Fall, Spring

Introduction to the analytical skills needed for the study of Physics. The focus is to prepare students to take PHYS 11A, however, PHYS 1 is also suitable as preparation for PHYS 5A. Emphasis is on reasoning and problem-solving, including conceptualization, visualization, and interpretation of written descriptions of physical situations, and on the connection of physical laws to the mathematical techniques used in their solution.

PHYS 2. Topics in Elementary Physics. 4 Units
Prerequisite(s): A recent one year course in high school algebra and one year of plane geometry or a college course in algebra (MATH 9).
Term Typically Offered: Fall, Spring

One semester introductory physics course including a laboratory. Covers the fundamental concepts of physics with an emphasis on everyday life situations and applications. The range of material includes mechanics, waves, electricity and optics. One hour lecture, two hour discussion, and a three hour laboratory session.

PHYS 5A. General Physics: Mechanics, Heat, Sound. 4 Units
Prerequisite(s): Recently completed three years of high school algebra and geometry; and a college course in algebra and trigonometry (MATH 9 recommended) for those having an inadequate mathematics background.
General Education Area/Graduation Requirement: Laboratory (B3), Physical Science (B1)
Term Typically Offered: Fall, Spring, Summer

PHYS 5A-B sequence is a two-semester course in introductory physics in which fundamental concepts are emphasized including some physiological applications. Lecture two hours; discussion one hour; laboratory three hours.

PHYS 5B. General Physics: Light, Electricity and Magnetism, Modern Physics. 4 Units
Prerequisite(s): PHYS 5A or instructor permission.
Term Typically Offered: Fall, Spring, Summer

Lecture two hours; discussion one hour; laboratory three hours.

PHYS 10. Physics In Our World. 3 Units
General Education Area/Graduation Requirement: Physical Science (B1)
Term Typically Offered: Fall, Spring

Introductory course designed for non-science students completing general education requirements. Students will be introduced to basic concepts in Physics through the study of astronomy, atomic nature of matter, electromagnetic waves, energy, sound and earthquake waves, current electricity, magnetism, and nuclear processes. Development of reasoning and quantitative skills and applying them to scientific and technological topics of current importance will be emphasized.

PHYS 10L. Physics in Our World Laboratory. 1 Unit
Prerequisite(s): PHYS 10; may be taken concurrently.
Term Typically Offered: Fall, Spring

Laboratory course complements PHYS 10 and satisfies the general education science lab requirement. Emphasis is placed on the nature of scientific observation and measurement and their relationship to general physical concepts. Students will be given a concrete, hands-on sense of observing and interpreting data from a variety of experimental environments.

PHYS 11A. General Physics: Mechanics. 4 Units
Prerequisite(s): MATH 30, MATH 31; or equivalent certificated high school courses. MATH 31 may be taken concurrently.
General Education Area/Graduation Requirement: Physical Science (B1), Laboratory (B3)
Term Typically Offered: Fall, Spring, Summer

PHYS 11 A, B, and C is a three semester course in introductory physics requiring elementary calculus. This course satisfies the lower division physics requirement for a major in physics, chemistry, geology, or engineering. PHYS 11A covers the basics of classical mechanics, including kinematics, Newton's laws, conservation laws and rotational dynamics. Lecture two hours; discussion one hour; laboratory three hours.

PHYS 11B. General Physics: Heat, Light, Sound, Modern Physics. 4 Units
Prerequisite(s): PHYS 11C.
Term Typically Offered: Fall, Spring

PHYS 11 A, B, and C is a three semester course in introductory physics requiring elementary calculus. This course satisfies the lower division physics requirement for a major in physics, chemistry, geology, or engineering. PHYS 11B covers the basics of thermodynamics, light propagation, sound, and an introduction to modern physics. Lecture two hours; discussion one hour; laboratory three hours.

PHYS 11C. General Physics: Electricity and Magnetism. 4 Units
Prerequisite(s): MATH 31, PHYS 11A.
Term Typically Offered: Fall, Spring, Summer

PHYS 11 A, B, and C is a three semester course in introductory physics requiring elementary calculus. This course satisfies the lower division physics requirement for a major in physics, chemistry, geology, or engineering. PHYS 11C covers the basics of electricity and magnetism. Lecture two hours; discussion one hour; laboratory three hours.

PHYS 30. Science and Pseudoscience. 3 Units
General Education Area/Graduation Requirement: Critical Thinking (A3)
Term Typically Offered: Fall, Spring

Examination of the methodology of science. Comparison of legitimate investigations with others that do not meet high scientific standards, including both science poorly done and nonsense posing as science. Examples will be drawn primarily from the physical sciences. Analyzes will require study of basic skills of reasoning, types of logical argument, structure and validity of arguments, common reasoning fallacies, critical evaluation of evidence, and understanding of the scientific thinking process.

PHYS 99. Special Problems. 1 - 3 Units
Term Typically Offered: Fall, Spring

Individual projects or directed reading.
Note: Open only to students who appear competent to assume individual work on the approval of the instructor. For students with lower division status. Up to 4 units may be taken for grade.

Credit/No Credit

PHYS 105. Mathematical Methods in Physics. 3 Units
Prerequisite(s): MATH 32, MATH 45, PHYS 11A, PHYS 11B, PHYS 11C or PHYS 5A, PHYS 5B.
Term Typically Offered: Fall only

Linear algebra, linear vector spaces, linear transformations, the eigenvalue problem, Sturm-Liouville Theory. Solving PDEs common to physical systems. Fourier transforms, Dirac delta function, differential and integral vector calculus with a focus on applications to problems in physics, such as classical mechanics, thermodynamics, quantum mechanics, and electromagnetism.

PHYS 106. Introduction to Modern Physics. 3 Units
Prerequisite(s): MATH 31; PHYS 11A, PHYS 11B, PHYS 11C or PHYS 5A, PHYS 5B.
Term Typically Offered: Fall, Spring

Basic concepts of special relativity and quantum theory of matter. Phenomenological study of atomic and molecular energy states and spectra. Elements of solid-state and nuclear physics.

PHYS 107. Conceptual Physics and Scientific Inquiry. 4 Units
Prerequisite(s): BIO 7, CHEM 106, GEOL 8, MATH 17.
Corequisite(s): CHEM 106
Term Typically Offered: Fall, Spring

Concepts include matter, waves and energy, force and motion, electricity and magnetism, and scientific inquiry. Emphasizes hands on cooperative learning engaging students in scientific inquiry by posing testable scientific questions, conducting experiments, and analyzing and presenting findings to their peers. Appropriate for Liberal Studies and Blended Multiple Subject Credential students. Weekly activity and discussion sessions.

PHYS 110. Classical Mechanics. 3 Units
Prerequisite(s): MATH 45, PHYS 11C, PHYS 105.
Term Typically Offered: Spring only

Fundamental principles of statics and dynamics, including Newton's equations and conservation laws, damped and forced oscillations, central force motion, accelerated coordinate systems, coupled oscillations, normal modes, Lagrangian and Hamiltonian methods, introduction to nonlinear systems and chaos theory.

PHYS 115. Electronics and Instrumentation. 4 Units
Prerequisite(s): PHYS 11C or PHYS 5B with instructor permission.
Term Typically Offered: Fall only

Linear and non-linear circuits, operational amplifiers, transducers, basics of digital circuitry, and an introduction to computerized data acquisition. Lecture two hours; laboratory six hours.

PHYS 116. Advanced Electronics and Instrumentation. 3 Units
Prerequisite(s): PHYS 115.
Term Typically Offered: Spring only – even years

Noise reduction techniques, signal recovery, frequency analysis, computerized instrument control, and instrument development. Lecture one hour; laboratory six hours.

PHYS 124. Thermodynamics and Statistical Mechanics. 3 Units
Prerequisite(s): MATH 45, PHYS 11A, PHYS 11B, PHYS 11C.
Term Typically Offered: Spring only

Basic concepts and laws of thermodynamics and thermal properties of matter; kinetic theory of gases; use of distribution functions and ensembles in statistical mechanics; connection of probability and entropy; quantum statistics; applications to various systems.

PHYS 130. Acoustics. 3 Units
Prerequisite(s): MATH 45, PHYS 11A, PHYS 11B, PHYS 11C.
Term Typically Offered: Fall, Spring

Theoretical and experimental study of sound sources, sound waves and sound measurement. Basic properties of waves in continuous media; spectral analysis of vibrations; use of acoustic impedance and circuit analogies; applications to environmental noise analysis, room acoustics, and loudspeaker and microphone design and use; experience with acoustic instrumentation. Lecture two hours; laboratory three hours.

PHYS 135. Electricity And Magnetism. 3 Units
Prerequisite(s): MATH 45, PHYS 11C, PHYS 105.
Term Typically Offered: Spring only

Development of electromagnetic theory from basic experimental laws; electrostatics, electric currents, magnetostatics, electric and magnetic properties of matter, induction, Maxwell's equations, conservation laws, introduction to electromagnetic waves.

PHYS 136. Electrodynamics of Waves, Radiation,and Materials. 3 Units
Prerequisite(s): PHYS 135.
Term Typically Offered: Fall only

Electromagnetic waves, wave propagation in material media, reflection and refraction, polarization, cavities and waveguides, optical fibers, simple radiating systems, radiation from an accelerated charge and special relativity. Introduction to plasma physics and electromagnetic properties of superconductors.

PHYS 142. Applied Solid State Physics. 3 Units
Prerequisite(s): MATH 45, PHYS 106.
Term Typically Offered: Fall, Spring

Elementary treatment of crystal structure and lattice and electron dynamics. Physics of semiconductor junctions, diodes, transistors and MOSFETS, solar cells, lasers, electro-optic and acousto-optic devices. Introduction to basic physical properties such as electrical conduction of selected amorphous solids and their applications. Laboratory experience.

PHYS 145. Optics. 3 Units
Prerequisite(s): MATH 45, PHYS 11A, PHYS 11B, PHYS 11C.
Term Typically Offered: Spring only – odd years

Theoretical and experimental treatment of wave optics; interference, diffraction, absorption, scattering, dispersion, polarization. Selected topics from contemporary optics: Fourier optics, coherence theory, lasers, holography. Lecture two hours; laboratory three hours.

PHYS 150. Quantum Mechanics. 3 Units
Prerequisite(s): MATH 45, PHYS 106, PHYS 110.
Term Typically Offered: Fall only

Foundations of wave mechanics, including wave packets, superposition, and the uncertainty principle. The Schroedinger equation and its relation to operators and eigenstates. Symmetric systems and conserved quantities. Introduction to matrix mechanics, spin, scattering, and perturbation theory.

PHYS 151. Advanced Modern Physics. 3 Units
Prerequisite(s): PHYS 150.
Term Typically Offered: Spring only

Structure of matter including basic elements of atomics, molecular, solid state, nuclear and particle physics. Topics will also include photon and electron gases, lasers, superconductivity, Bose-Einstein condensation and superfluidity.

PHYS 156. Classical and Statistical Mechanics. 3 Units
Prerequisite(s): PHYS 110, PHYS 124.
Term Typically Offered: Fall only

Review of classical mechanics, Lagrangian and Hamiltonian formulations, rigid body motion, small vibrations and normal modes, nonlinear dynamics and chaos. Review of the laws of thermodynamics, principles of classical statistical mechanics, ensemble formulations and applications, principles of quantum statistical mechanics, ideal quantum gases, applications to Fermi-Dirac and Bose-Einstein systems.

PHYS 162. Scientific Computing: Basic Methods. 3 Units
Prerequisite(s): MATH 26A or MATH 30 and PHYS 5A, or MATH 30 and PHYS 11A, or MATH 105A concurrently.
Term Typically Offered: Fall only

Basic methods and skills of applying computers to the solution of scientific problems. Numerical calculation methods, numbers and data, algebraic equations, rate processes, iterative techniques, approximation methods, statistical analysis and data fitting, relaxation methods, and use of software and other programming resources on the web. Practical experience emphasized throughout.

PHYS 163. Scientific Computing: Modeling, Simulation, and Visualization. 3 Units
Prerequisite(s): PHYS 162.
Term Typically Offered: Spring only

Application of computer modeling, simulation, and visualization to the solution of scientific problems. Projects drawn from various scientific disciplines will be used to develop the necessary skills, including a capstone project. Examples include projectile motion with air drag, time development of a biological population, chemical reactions with several reactants, and random walk and Monte Carlo methods. Practical experience emphasized throughout.

PHYS 172. Biological Physics. 3 Units
Prerequisite(s): MATH 26A or MATH 30. PHYS 5A and PHYS 5B; or PHYS 11A and PHYS 11B and PHYS 11C.
Term Typically Offered: Fall only

Investigation of subcellular and cellular biological systems using the fundamentals of physics. Topics will include a quantitative treatment of: the role of forces and energy in biology; thermodynamics of living systems; biopolymer, cytoskeletal and cellular mechanics; the physics of molecular motors and intracellular transport; applications of physical tools to study biological systems. Focus is on the interplay between physics and biology, and on how physical properties determine the biological function and behavior of living systems.
Note: PHYS 11B or PHYS 5B may be taken concurrently with instructors consent; no biology coursework is required, though some knowledge of cell biology is helpful, and it is recommended that students consider taking a lower-division college course in biology prior to enrollment.

PHYS 175. Advanced Physics Laboratory. 2 Units
Prerequisite(s): 12 units of upper division physics, including PHYS 106 and either PHYS 115 or PHYS 145 and a satisfaction of the Advanced Writing requirement.
Term Typically Offered: Fall, Spring

Advanced experiments chosen from several of the major areas of physics, performed usually on an individual basis. Laboratory six hours.

PHYS 181. Modern Physics for Everyone. 3 Units
Prerequisite(s): Completion of GE Area B1 and B4.
General Education Area/Graduation Requirement: Further Studies in Area B (B5), Upper Division Further Studies in Area B5
A conceptual course in the topics of modern physics including Quantum Mechanics, Special Relativity, and other contemporary topics for a general audience. This course meets General Education Area B5 (Further Studies in Physical Science, Life Forms, and Quantitative Reasoning) and satisfies the upper-division Area B requirement.

PHYS 182. Physics of Sports. 3 Units
Prerequisite(s): Completion of GE Area B1 and B4.
General Education Area/Graduation Requirement: Upper Division Further Studies in Area B5, Further Studies in Area B (B5)
Term Typically Offered: Fall, Spring

A conceptual course in the application of the laws of physics in the context of sport. Focusing mainly on classical physics, we will cover topics such as force, energy, momentum, collisions, pressure, and fluids to explain what we see on the court, field, pool, and road. This course meets General Education Area B5 (Further Studies in Physical Science, Life Forms, and Quantitative Reasoning) and satisfies the upper-division Area 8 requirement.

PHYS 184. Physics of Energy and the Environment. 3 Units
Prerequisite(s): Completion of GE Area B1
General Education Area/Graduation Requirement: Further Studies in Area B (B5), Upper Division Further Studies in Area B5
Term Typically Offered: Fall, Spring

Our society requires and consumes energy. In this course, students will gain an understanding of the wide variety of our energy sources and how the energy is generated, distributed, and stored. We will examine the large scale and small scale role that energy plays in society and the impact that energy policy and practices have on the environment.

PHYS 186. Musical Acoustics: Science and Sound. 3 Units
General Education Area/Graduation Requirement: Upper Division Further Studies in Area B5, Further Studies in Area B (B5)
Term Typically Offered: Fall, Spring

Physical principles of vibration and wave motion, with illustrations involving musical instruments and concert hall acoustics; principles of electronic synthesis, recording, and reproduction of sound; operation of the human ear and brain in receiving and analyzing sound; relation of the harmonic series to sound quality, harmony and scales; proper roles for science in explaining music as an artistic activity.
Note: No technical background required; course cannot be used to meet Physics BS program requirements. It is recommended that student have already completed their B1 and B4 requirement prior to enrollment. Some experience with music is also helpful.

PHYS 187. Seeing the Light. 3 Units
Prerequisite(s): Completion of GE Area B1 and B4.
General Education Area/Graduation Requirement: Further Studies in Area B (B5), Upper Division Further Studies in Area B5
Term Typically Offered: Fall only

An extensive study of light, mostly in the context of applications. Topics include basics of light and natural phenomena, optics, color, light and energy (solar power), and holography; as well as more advanced topics such as wave/particle model of light, diffraction and polarization. The course will also cover optical instrumentation such as cameras, microscopes, telescopes, displays, and photoreceptors.

PHYS 190. Physics Seminar. 1 - 2 Units
Term Typically Offered: Fall, Spring

Special lecture series on announced topics by local and visiting speakers, emphasizing current research developments, with related reading assignments.
Note: May be taken for credit in sequential semesters for a maximum of two units total.

Credit/No Credit

PHYS 191. Senior Project. 1 - 2 Units
Prerequisite(s): Department chair permission.
Term Typically Offered: Fall, Spring

Research Project under faculty supervision. Project may consist of laboratory or theoretical research project, instrumentation/demonstration development, or literature research project. Projects require written and oral reports.
Note: May be taken for credit in sequential semesters for a maximum of four units total. Grade assigned upon completion of the project.

PHYS 194. Physics Related Work Experience. 6 - 12 Units
Prerequisite(s): Upper-division status and Department Chair permission.
Term Typically Offered: Fall, Spring

Supervised employment in a physics or astronomy related company or agency. Placement is arranged through the department and the Cooperative Education Program office. Requires completion of a three-to-six month work assignment and a written report.
Note: PHYS 194 may not be used to meet major requirements in Physics; May be taken for credit in sequential semesters

Credit/No Credit

PHYS 195. Teaching Internship. 1 - 2 Units
Prerequisite(s): Completion of all math and physics lower division courses for the B.A. in Physics. Approval from the Teacher Preparation Concentration Coordinator.
Term Typically Offered: Fall, Spring

Supervised teaching internship for high school physics class, or for one of the following courses: PHYS 2, 5A-B, 10, 11A-C, 107, or ASTR4. The students will meet weekly with the faculty teaching this class, and with their supervisor or mentor to help prepare and teach the class.
Note: May be taken for credit in sequential semesters for a maximum of six units total.

PHYS 197. Laboratory Teaching Assistant. 1 - 2 Units
Prerequisite(s): Completion of all physics and math lower division courses required for the B.A. in Physics. Completion of the same course in which the student will take this class with a grade higher than B and/or consent from the Teacher Preparation Concentration program coordinator.
Term Typically Offered: Fall only

Student will be a supervised laboratory teaching assistant for one of the following courses: PHYS 2, 5A-B, 10, 11A-C, 107, or ASTR 6. The student will meet weekly with the faculty teaching this class, and with their supervisor or mentor to help prepare and teach the laboratory.
Note: May be taken for credit in sequential semesters for a maximum of six units total.

PHYS 198. Co-Curricular Activities. 1 - 3 Units
Term Typically Offered: Spring only

Students may provide special tutoring to students taking physics courses, participate in community oriented projects, assist in activity sessions for teacher training courses, or engage in activities related to the subject matter and concerns of the Physics and Astronomy Department. Up to 4 units may be taken.
Credit/No Credit

PHYS 199. Special Problems. 1 - 3 Units
Term Typically Offered: Fall, Spring

Individual projects or directed reading. Open only to students who appear competent to assume individual work on the approval of the instructor. Up to 4 units may be taken for grade.
Credit/No Credit

PHSC 75. Introduction to Machine Shop Practices. 2 Units
Term Typically Offered: Fall, Spring

Safe machine operation techniques on common fabrication equipment. Study of materials and methods used to build testing and measuring equipment. Reading and calibrating measuring devices, gauging and optical gauging. Study of measuring conventions and understanding of precision. Interpretation of drawings, tolerances and tactics for maintaining tolerances. Jigs and mounts for dynamic data collection equipment. Prototype manufacturing. Students completing this course qualify to perform work in the shop with minimum supervision. Lecture one hour; Laboratory three hours.

PHSC 107. History of the Physical Sciences. 3 Units
General Education Area/Graduation Requirement: Further Studies in Area B (B5), Upper Division Further Studies in Area B5
Term Typically Offered: Fall, Spring

Study of the development of the major physical laws presently used in describing our physical world. Some considerations of the influences of these developments on other areas of knowledge and on society in general.
Cross Listed: HIST 107; only one may be counted for credit.

PHSC 199. Special Problems. 1 - 3 Units
Term Typically Offered: Fall, Spring

Individual projects or directed reading.
Note: Open only to students who appear competent to assume individual work on the approval of the instructor. Up to 4 units may be taken for grade.

Credit/No Credit