

APPLIED PHYSICS**Office:**

Science Hall 2, Second Floor

Telephone:

(760) 750-4273

Department Chair:

Vacant.

Faculty:

Michael J. Burin, Ph.D.
 Charles J. De Leone, Ph.D.
 Gerardo Dominguez, Ph.D.
 Graham Oberem, Ph.D.
 Edward P. Price, Ph.D.
 Stephen A. Tsui, Ph.D.

Program Offered:

- Bachelor of Science in Applied Physics, Options in:
 - Applied Physics
 - Applied Electronics
- Minor in Physics*

Physics is a study of matter and its interaction at the fundamental level. Physicists seek to measure, understand, model, and control the processes in the physical world around us. To this end, physicists use a variety of descriptive and quantitative techniques to represent their knowledge. Furthermore, this work is conducted in a community where collaboration, teaching, and communication of results are essential. Applied physics makes a connection between fundamental research in physics and its application to real-world problem-solving. Research in applied physics has led to the use of electricity and magnetism for lighting and propulsion, given birth to the semiconductor industry that has provided us with the conveniences of modern electronics, and played an important part in the development of biomedical technology. While engineers have perfected many of these inventions, applied physicists have been responsible for their discovery.

The degree in applied physics prepares students to succeed in a wide range of entry-level positions in the high technology and biotechnology industry by giving them a broad and rigorous grounding in the principles of physics, while at the same time emphasizing the application of physics to real-world problems.

*See page 317 for Minor in Physics.

Applied physics baccalaureate-level graduates will have unique critical thinking and problem-solving abilities that will be valuable to employers in a wide range of technical fields.

The Applied Physics Degree requires the completion of 120 semester units in one of two options, Applied Physics or Applied Electronics, each of which allows students to focus on a particular area of interest. Both options will provide opportunities for student research in collaboration with faculty in the Physics Department. These undergraduate research opportunities will provide valuable training that will make graduates more competitive in the job market.

Student Learning Outcomes

Students who graduate with a Bachelor of Science in Applied Physics will be able to:

1. Carry out the process of scientific investigation, using appropriate lab techniques and safety procedures.
2. Apply mathematical techniques to represent, model, and solve physics problems, including real-world problems.
3. Write simple computer programs that control scientific experiments, gather physical data, and model or simulate physical processes.
4. Apply specific knowledge in the areas of mechanics, electromagnetism, thermal physics, and quantum phenomena to problem solve in these fields and to real-world applications.
5. Design, troubleshoot, and test analog and digital electronic circuits for real-world applications.
6. Keep a laboratory notebook and know how to present scientific information as a technical article, as a formal journal article, or as a public oral presentation.

Preparation

Freshman applicants must complete a comprehensive program of college preparatory study totaling between 24 and 28 units, depending on the option chosen. Transfer students entering at the junior and senior level should have completed the equivalent required physics and supporting courses elsewhere. All courses taken for the major, including supporting courses, must be completed with a grade of C (2.0) or better.

Degree Requirements

Either option for the Bachelor of Science in Applied Physics requires the completion of 120 semester units. As a part of each option, students are required to complete 51 units of General Education courses. Six (6) to nine (9) units of lower-division General Education, including the laboratory requirement in Area B (Math and Science), are automatically satisfied by combinations of CHEM 150, CS 111, MATH 160, and PHYS 201. The exact number of units satisfied in this way will depend on the option chosen. A minimum of eighteen (18) units in Physics must be completed at Cal State San Marcos.

Applied Physics Option

This option is intended for those students who wish to pursue a career in industry where the application of the principles of physics might be important in modeling, or in research and development.

| | Units |
|----------------------------|--------------|
| General Education* | 51 |
| Preparation for the Major* | 39-40 |
| Option Requirements | 35-36 |

Students must take a sufficient number of elective units to bring the total number of units to a minimum of 120

**Six (6) lower-division General Education units in Area B (Math and Science) are automatically satisfied by courses taken in Preparation for the Major.*

Preparation for the Applied Physics Option

Non-Physics Supporting Courses (24-25 units)

| | |
|-----------|---|
| CHEM 150† | 5 |
| CS 111† | 4 |
| MATH 160† | 5 |
| MATH 162† | 4 |
| MATH 346 | 3 |

Lower-Division Physics Courses (15 units)

| | |
|-----------|---|
| PHYS 201† | 4 |
| PHYS 202 | 4 |
| PHYS 203 | 4 |
| PHYS 280 | 3 |

Choose one of the following courses:

| | |
|-----------------|---|
| MATH 260† | 4 |
| MATH 362 | 3 |
| MATH 270 or 370 | 3 |
| MATH 374 | 3 |

† These courses supporting the preparation or electives in the major may satisfy the Mathematics and Physical Science requirements of General Education.

Option Requirements

Upper-Division Physics Courses (25 units)

| | |
|----------------------|---|
| PHYS 320 | 3 |
| PHYS 321 | 3 |
| PHYS 323 | 3 |
| PHYS 324 | 3 |
| PHYS 421 | 3 |
| PHYS 422 | 3 |
| PHYS 423 | 3 |
| PHYS 380 or PHYS 480 | 2 |
| PHYS 499B | 2 |

Electives for the Major (10-11 units)

Select elective courses from the following list:

| | |
|-----------|---|
| CHEM 402 | 3 |
| PHYS 301 | 4 |
| PHYS 380* | 2 |
| PHYS 402 | 4 |
| PHYS 403 | 3 |
| PHYS 480* | 2 |

** PHYS 380 or PHYS 480 may be chosen as an elective, if it has not already been taken as part of the upper-division core.*

Students may also take up to six (6) units of elective courses in another major in the natural or mathematical sciences, chosen in consultation with and approved by the Physics Academic Advisor prior to taking the course.

Applied Electronics Option

This option is intended for those students who wish to pursue a career in which an understanding of the design of electronic devices, possibly interfaced to computers and/or research equipment, is required.

| | |
|----------------------------|-------|
| General Education* | 51 |
| Preparation for the Major* | 42-43 |
| Option Requirements | 32-33 |

Students must take a sufficient number of elective units to bring the total number of units to a minimum of 120

** Six (6) lower-division General Education units in Area B (Math and Science) are automatically satisfied by courses taken in Preparation for the Major.*

Preparation for the Applied Electronics Option

Lower-Division Physics Courses (15 units)

| | Units |
|-----------|--------------|
| PHYS 201† | 4 |
| PHYS 202 | 4 |
| PHYS 203 | 4 |
| PHYS 280 | 3 |

† These courses supporting the preparation or electives in the major may satisfy the Mathematics and Physical Science requirements of General Education.

Non-Physics Supporting Courses (27-28 units)

| | |
|-----------|---|
| CS 111† | 4 |
| CS 211 | 4 |
| CS 231 | 4 |
| MATH 160† | 5 |
| MATH 162† | 4 |
| MATH 346 | 3 |

Choose one of the following courses:

| | |
|-----------------|---|
| MATH 260† | 4 |
| MATH 362 | 3 |
| MATH 270 or 370 | 3 |
| MATH 374 | 3 |

Option Requirements

Upper-Division Physics Courses (24 units)

| | |
|----------------------|---|
| PHYS 301 | 4 |
| PHYS 320 | 3 |
| PHYS 321 | 3 |
| PHYS 323 | 3 |
| PHYS 402 | 4 |
| PHYS 403 | 3 |
| PHYS 380 or PHYS 480 | 2 |
| PHYS 499B | 2 |

Electives for the major 8-9

Select elective courses from the following list:

| | |
|-----------|----------|
| CS 331 | PHYS 324 |
| PHYS 380* | PHYS 421 |
| PHYS 422 | PHYS 423 |
| PHYS 480* | |

*PHYS 380 or PHYS 480 may be chosen as an elective, if it has not already been taken as part of the upper-division core.

Students may also take up to six (6) units of elective courses in another major in the natural or mathematical sciences, chosen in consultation with and approved by the Physics Academic Advisor prior to taking the course.

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Program Offered:

- Minor in Physics

Physics is a study of the fundamental macroscopic and microscopic properties of nature, from the building blocks of matter to the origin, extent, and future of the universe itself. Physicists seek to measure, understand, model, and control the processes in the physical world around us.

Requirements

Completion of a minimum of twenty-three (23) units, eleven (11) of which must be at the upper-division level. Students must earn a grade of C (2.0) or better in each class in the minor.

| | Units |
|--|--------------|
| a. Required lower-division (12) | |
| Choose one of the two sequences: | 8 |
| PHYS 201 and 202 (4 units each) | |
| or | |
| PHYS 205 and 206 (4 units each) | |
| PHYS 203 | 4 |
| b. Required upper-division (8). At least eight (8) units chosen from any PHYS course numbered 300 or higher that can be counted towards the B.S. in Applied Physics | |
| c. Additional coursework as necessary, if the courses in (a) and (b) do not account for the required minimum twenty-three (23) units. Up to six (6) units of upper-division coursework in other science majors may be counted, with the written approval of a physics advisor. | |

Total Units

23

PHYSICS (PHYS)**College of Science and Mathematics****PHYS 101 (4)****Introduction to Physics I**

An overview of the principles of mechanics, thermodynamics, and waves. The areas covered include: observation and measurement, kinematics, dynamics, work and energy, impulse, and momentum, fluids, heat and temperature, oscillations, and waves in mechanical media. *Three hours of lecture and three hours of laboratory. Enrollment Restriction: Completion of the Lower-Division General Education requirement in Mathematics/Quantitative Reasoning (B4). Enrollment Requirement: Completion of a course in trigonometry at the high school or university level.*

PHYS 102 (4)**Introduction to Physics II**

An overview of the principles of electricity and magnetism, light and optics, and modern physics. The areas covered include: electric charge, electric fields, electric potential, DC circuits, magnetism, magnetic fields, geometrical and physical optics, and atomic and nuclear physics. *Three hours of lecture and three hours of laboratory. Enrollment Requirement: PHYS 101.*

PHYS 201 (4)**Physics of Mechanics and Sound**

A broad coverage of the principles of mechanics and wave motion. The areas covered include: observation and measurement, kinematics, dynamics, work and energy, impulse and momentum, equilibrium of rigid bodies, rotational motion, oscillations, and waves in mechanical media. Required for students whose field of study is physics, chemistry, or computer science. *Three hours of lecture and three hours of laboratory. Recommended Preparation: High school physics. Enrollment Requirement: Completion of MATH 160 with a minimum grade of C (2.0).*

PHYS 202 (4)**Physics of Electromagnetism and Optics**

A broad coverage of classical electromagnetism and optics. The areas covered include: electric charge, electric fields, electric potential, capacitors and dielectrics, DC circuits, magnetic fields, magnetic properties of matter, AC circuits, Maxwell's equations, electromagnetic waves, the nature and propagation of light, geometrical optics, and wave optics. *Three hours of lecture and three hours of laboratory. Enrollment Requirement: PHYS 201 or 205, and MATH 162 with a minimum grade of C (2.0) in each.*

PHYS 203 (4)**Modern Physics**

An overview of the fundamental ideas of modern physics and coverage of the principles of fluids and thermodynamics. The areas covered include: fluids, temperature, heat, the kinetic theory of gases, entropy, and the laws of thermodynamics, along with the theory of special relativity, wave particle duality, an introduction to quantum mechanics and atomic physics, the electronic properties of solids, nuclear physics, and a descriptive introduction to the standard model and cosmology. *Three hours of lecture and three hours of laboratory. Enrollment Requirement: PHYS 202 or 206.*

PHYS 205 (4)**Physics for the Biological Sciences I**

A broad coverage of the principles of mechanics, properties of matter and wave motion. The subjects covered include: observation and measurement, kinematics, dynamics, energy, momentum, equilibrium, fluids and solids, thermodynamics, oscillations, and waves. *Required for students whose field of study is biology. Three hours of lecture and three hours of laboratory. Recommended Preparation: High school physics or an introductory college level physics course. Co/Prerequisite: MATH 160.*

PHYS 206 (4)**Physics for the Biological Sciences II**

A broad coverage of electromagnetism, optics, and nuclear physics. The areas covered include: electrostatics, electric fields, magnetism, magnetic fields, electric circuits, geometrical optics, optical instruments, nuclear physics, radiation, and spectroscopy. *Required for students whose field of study is biology. Three hours of lecture and three hours of laboratory. Enrollment Requirement: Completion of PHYS 201 or 205, and MATH 160 with a minimum grade of C (2.0) in both courses.*

PHYS 210 (1)**Problem Solving in Physics**

Problem solving sessions focused on interpreting physical situations and applying physics concepts to solve problems. Students will practice using graphical and mathematical representations, planning and carrying out solutions, and assessing answers. Participation in these sessions can improve student performance in traditionally difficult courses. Strongly recommended for all students enrolled in lower-division physics courses. *Corequisite: Enrollment in the appropriate lower-division Physics course. The content of each course is reflected by its subtitle. May be repeated as course number (below) changes for a maximum of three (3) units.*

- A. Problem solving for PHYS 201
- B. Problem solving for PHYS 202
- C. Problem solving for PHYS 203
- D. Problem solving for PHYS 205
- E. Problem solving for PHYS 206

PHYS 280 (3)**Introduction to Electronics**

Introduction to the design and measurement techniques of modern electronics. Includes AC circuit theory, passive filters, semiconductor diodes, transistors, operational amplifiers, including active filters, and a general introduction to digital circuits. The activities provide students with an opportunity for hands-on experience with a wide range of electronic circuits. *Two hours of lecture and two hours of activity. Recommended completion or concurrent enrollment: PHYS 203. Enrollment Requirement: PHYS 202.*

PHYS 301 (4)**Digital Electronics**

Introduction to digital computer hardware design including: gates, flip-flops, registers, and memory to perform logical and arithmetic operations on numeric and other data represented in binary form. The laboratory uses digital logic integrated circuitry for experiments with combinational and sequential networks, and simple digital systems. *Enrollment Requirement: CS 231, PHYS 202 or 206, and MATH 270.*

PHYS 306 (3)**Introduction to Physics Education Research**

An introduction to research in physics education and research-based physics teaching. Subjects include how people learn and understand physics concepts and the nature of science. Additional subjects will include research-based curricula, pedagogical approaches, and challenges associated with implementing novel teaching methods. Useful for students interested in teaching and learning physical sciences. *Enrollment Requirement: PHYS 203.*

PHYS 315 (3)**Science in Film and TV**

Intended for the non-science major, the goal of this course is to introduce students to the fundamental concepts in the physical and life sciences. Popular motion pictures, television programs and commercials, and video documentaries that contain scientific themes will be used to introduce relevant concepts, and will also serve as a common background from which students can expand their scientific understanding. *Also offered as CHEM 315. Students may not receive credit for both.*

PHYS 320 (3)**Classical Mechanics**

Classical mechanics and associated mathematical and numerical techniques: principles of Newtonian mechanics, and an introduction to Hamiltonian and Lagrangian Dynamics. Applications to central force problems and small vibrations, and other selected topics in mechanics, including applications in engineering and biological systems. *Enrollment Requirement: PHYS 203.*

PHYS 321 (3)**Electromagnetism**

Introduction to the applications of Maxwell's Equations and the propagation of EM waves in relation to matter. Subjects to be covered include: dielectrics, conductors, plasmas, and waveguides, and selected topics in EM wave radiation, propagation, absorption, transmission, and diffraction. *Enrollment Requirement: PHYS 203 and MATH 260.*

PHYS 323 (3)**Quantum Physics**

A survey of quanta based physical theories, and their experimental foundations and applications: quantum physics of atoms, molecules, nuclei, and electrons; introduction to condensed matter physics. *Recommended Preparation: MATH 346. Enrollment Requirement: PHYS 203.*

PHYS 324 (3)**Statistical Mechanics and Thermodynamics**

Covers the laws of thermodynamics with applications to ideal and non-ideal systems. Includes elementary kinetic theory of gases, entropy, and classical and quantum statistical mechanics. Other topics covered may include magnetism and low-temperature physics. *Enrollment Requirement: PHYS 203.*

PHYS 351 (3)**How Things Work**

An examination of the everyday objects and technologies that surround us. Familiar objects are used as a context for exploring basic physical principles. Among other topics, the course will explore how microwave ovens, cameras, hard drives, and photocopiers work. *No previous coursework in science or technology is assumed; intended for science and non-science majors.*

PHYS 356 (3)**The Science of Sound and Music**

An introduction to the physics of sound. Various aspects of the science of sound are covered, including the nature of sound waves and their production, recording, and reproduction. The physics of musical instruments, digital synthesis of sounds, and the basics of room and auditorium acoustics are also studied. *Enrollment restricted to students who have completed the Entry Level Mathematics (ELM) Requirement.*

PHYS 380 (2)**Applied Laboratory Techniques**

Experimental work, including an introduction to the equipment and techniques used in mechanics, electromagnetism, optics, electronics, quantum physics, nuclear physics, biophysics, medical physics, and/or geophysics. An emphasis will be placed on experimental design and data analysis. *Six hours of laboratory. Enrollment Requirement: PHYS 203.*

PHYS 402 (4)**Computer Interfacing and Control**

Introduction to the design and use of digital computer interfaces, including serial parallel, USB, and synchronous and asynchronous interfaces. The laboratory provides hands-on experience in computer interfacing through integrated circuits, sensors, and microcontrollers. *Three hours of lecture and three hours of laboratory. May not be taken for credit by students who have received credit for PHYS 302. Prerequisite: PHYS 301 with a minimum grade of C (2.0).*

PHYS 403 (3)**Signals and Systems Processing**

Introduction to signals and digital processing including: fundamentals of signals, signal processing, filter synthesis, discrete-time systems, discrete fourier transforms and FFT, Z-transforms, sampling quantization, and image processing. *Enrollment Requirement: PHYS 203 with a minimum grade of C (2.0).*

PHYS 421 (3)**Applied Electromagnetic Waves and Optics**

Includes radiation and propagation of electromagnetic waves, ray optics, physical optics, optical devices, laser optics, holography, and optics of vision. *Enrollment Requirement: MATH 162. Prerequisites: PHYS 321 and MATH 346.*

PHYS 422 (3)**Applied Solid State Physics**

Selected topics in solid-state physics. Includes crystal structure, thermal, electrical, and magnetic properties of solids, elementary band theory, semiconductors, and solid-state devices. *May not be taken for credit by students who have received credit for PHYS 322. Enrollment Requirement: PHYS 203, and an upper-division non-GE mathematics course.*

PHYS 423 (3)**Quantum Mechanics**

A study of the concepts and theories of nonrelativistic quantum mechanics. Includes the Schrodinger equation, operators, angular momentum, the hydrogen atom, and applications to simple quantum mechanical systems. *Prerequisites: PHYS 323 and MATH 346.*

PHYS 480 (2)

Advanced Applied Physics Laboratory

Experimental work, including in-depth experimentation in mechanics, electromagnetism, optics, electronics, quantum physics, computational physics, biophysics, medical physics, and/or geophysics. An emphasis will be placed on experimental design and data analysis. *Six hours of laboratory.*

Enrollment Requirement: PHYS 203 and 280.

PHYS 490 (1-3)

Topics Seminar

Selected advanced topics in physics. Focuses on one or more current issues in the physics literature. *A course description will be available before registration in the semester offered. May be repeated for credit as topics change. Students should check the Class Schedule for listing of actual topics.*

PHYS 498A (1) 498B (2) 498C (3)

Senior Library Thesis

Library or theoretical physics research project. The student must consult with a physics faculty member to decide on the topic and then produce a 10-20 page paper. The paper must summarize the current state of knowledge on the subject and include an appropriate bibliography. *May be repeated for a total of six (6) units. Enrollment restricted to students who have obtained consent of instructor.*

PHYS 499A (1) 499B (2) 499C (3)

Senior Laboratory Thesis

Experimental or laboratory physics research project. The student must consult with a physics faculty member to decide on the research problem and then work collaboratively under the guidance of the faculty member in the laboratory. The student will produce a 10-20 page paper summarizing the research and the results obtained. An appropriate bibliography must be included. *May be repeated for a total of six (6) units. Enrollment restricted to students who have obtained consent of instructor.*

POLITICAL SCIENCE (PSCI)

College of Humanities, Arts, Behavioral and Social Sciences

- CP = Comparative Politics
- GP = General Political Science
- INP = International Politics
- PT = Political Theory
- USGP = U.S. Government and Politics

PSCI 100 (3)

U.S. Government and Politics

The principles of the U.S. Constitution, and a survey of political institutions and processes that developed under it, including the legislature, the executive, the courts, state and local government, federalism, and civil liberties.

PSCI 301(3)

The Practice of Political Research

Introduction to methods of inquiry and analysis in political research. A variety of qualitative and quantitative approaches will be explored, including case studies, field research, archival studies, elite interviewing, surveys, and experimentation. Enrollment restricted to students with junior/senior standing with declared major in Political Science.

PSCI 305 (3)

Race, Ethnicity, Power and Politics in the U.S.

Processes and policies that have and have not incorporated racial and ethnic groups into the U.S. political system. Focuses on African-Americans, Latinos, and Asians. *Recommended Preparation: PSCI 100.(USGP)*

PSCI 321 (3)

Making Public Policy

Analysis of the process of policy making in the United States from problem identification through policy formulation, adoption, implementation, and evaluation of impact. Analysis applied to such areas as welfare, environment, crime, taxation, and government spending. *Enrollment Requirement: Completion of the Lower-Division General Education requirement in U.S. Constitution (Dc). (USGP)*

PSCI 331 (3)

World Political Systems

Comparative analysis of political behavior and institutions in political systems of different types. *May not be taken for credit by students who have received credit for PSCI 330. (CP)*

PSCI 335 (3)

European Politics

Study of the political systems of selected European nations that represent the various forms of government in the region. *Recommended Preparation: PSCI 331. (CP)*

PSCI 337 (3)

African Politics

Focus on the political systems of Africa. Problems of political development in the region; relations among selected African states, and relations with non-African systems. *Together with PSCI 449D, may be repeated for a total of six (6) units with consent of instructor. Recommended Preparation: PSCI 331. (CP)*

PSCI 338 (3)

Government and Politics of Selected Latin America Nation-State(s)

Detailed analysis of the government and politics of a particular Latin American nation-states. The content of each course is reflected by its title. *Students should check the Class Schedule for listing of actual topics. May be repeated as countries change for a total of six (6) units. Recommended Preparation: PSCI 331. (CP)*

PSCI 339 (3)

Introduction to the Politics of the Arab World

Introduction to the politics and societies of the Middle East and North Africa with emphases on dispelling common misconceptions about the Arab and Islamic world, the impact of European colonialism, and detailed analysis of the government and politics of particular Arab countries. *Recommended Preparation: PSCI 331.*