

5. **Abstract of the Proposal and Proposed Catalog Description**

APPLIED PHYSICS

Degree program offered: Bachelor of Science in Applied 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. 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, which 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. 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 members in the Physics Department. These undergraduate research opportunities will provide valuable training that will make graduates more competitive in the job market later.

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 will be expected to 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 GE, 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 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*	24-25
Option requirements	40
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)

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

Choose one of the following courses:

MATH 260†	4
MATH 362	3
MATH 370	3
MATH 374	3

Lower-division Physics courses (15 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.

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 499	2

Electives for the major 10-11

Select elective courses from the following list:

CHEM 402
PHYS 301
PHYS 380*
PHYS 402
PHYS 403
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.

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.

	Units
General Education*	51
Preparation for the major*	27-28
Option requirements	39
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

Non-physics supporting courses (27-28 units)

	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 370	3
MATH 374	3

Lower-division Physics courses (15 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.

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 499	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.

Catalog descriptions of all courses associated with the program:

CHEMISTRY (CHEM)

CHEM 150 General Chemistry (5). Introduction to many of the basic qualitative models and principles in chemistry. The areas covered include: basic nuclear and atomic structure, the periodic table, covalent and ionic bonding, states of matter, intermolecular forces, energy changes, chemical equilibria, acid-base chemistry, stoichiometry, properties of gases, and chemical properties of the

common elements. The laboratory experiments and projects are designed to complement lecture material and provide real-life applications of chemistry in society. *Counts towards the fulfillment of the Lower-division General Education Requirement in Physical Sciences and Its Life Forms. Three hours of lecture, one hour of discussion, and three hours of laboratory per week. Recommended: High School Chemistry. Prerequisite: Completion of Entry the Level Mathematics (ELM) requirement.*

CHEM 402 Physical Chemistry – Quantum (3). Designed to introduce the student majoring in science to the basic principles of Quantum Mechanics and Spectroscopy as applied to chemical problems. The areas covered include: quantum mechanics of model systems, electronic structure of atoms and molecules, and atomic and molecular spectroscopy. *Prerequisites: CHEM 250, MATH 162, and PHYS 201.*

COMPUTER SCIENCE (CS)

CS 111 Computer Science I (4). Emphasizes programming methodology and problem-solving. A block-structured, high level language such as C will be used for the specification and implementation of algorithms. Includes principles and applications of software engineering, numerical computing, artificial intelligence, database and user interface. *Three hours of lecture and three hours of laboratory. Prerequisites: MATH 115, 132, or equivalent.*

CS 211 Computer Science II (4). A continuation of program design and development. Introduction to data structures, stacks, queues, linear lists, trees, and sets. Includes pointers, recursion, and implementation and analysis of sorting and searching algorithms, problem state space, relational database, numerical approximation methods. *Three hours of lecture and three hours of laboratory. Prerequisite: CS 111 or equivalent.*

CS 231 Assembly Language and Digital Circuits (4). The structure of computers, number and character representation, word and instruction formats, and flowcharting. Machine and assembly language programming, address modification, indexing, indirect addressing, subroutines, and mnemonic interpreting systems. Includes digital logic and circuits of commonly used computer components. *Three hours of lecture and three hours of laboratory. Prerequisite: CS 111 or equivalent.*

CS 331 Computer Architecture (3). A study of the functional organization and sequential operation of digital computers. The major concepts of a computer will be discussed. Introduction to machine instruction architecture and design. The study of the internal operations during program execution. Several computer architectures will be studied. *Corequisite or Prerequisite: MATH 370. Prerequisite: PHYS 301 or equivalent.*

MATHEMATICS (MATH)

MATH 160 Calculus with applications I (5). Differential and integral calculus of functions of one variable: analytic geometry, limits, continuity, derivatives, analysis of curves, integrals, applications, algebraic, trigonometric, logarithmic, and exponential functions, historical perspectives. Includes a laboratory experience using either computers or graphing calculators. *Prerequisites: A strong background in high school mathematics (Algebra I and II, Geometry and Trigonometry) or MATH 125 with a minimum grade of C (2.0).*

MATH 162 Calculus with applications II (4). A continuation of differential and integral calculus: inverse trigonometric and hyperbolic functions, integration methods, intermediate forms, coordinate systems, planes and lines in space, sequences and series, applications, historical perspectives. Includes a laboratory experience using either computers or graphing calculators. *Prerequisite: MATH 160 (or equivalent) with a grade of C (2.0) or better.*

MATH 260 Calculus with applications III (4). Differential and integral calculus of functions of several variables: three-dimensional analytic geometry, vector calculus, partial derivatives, multiple integrals, line integrals, applications, historical perspectives. Includes a computer laboratory experience. *Prerequisite: MATH 162 (or equivalent) with a grade of C (2.0) or better.*

MATH 362 Differential Equations (3). Analysis and application of ordinary differential equations: linear and nonlinear equations, existence and uniqueness theorems, analytic methods, qualitative analysis of solutions, numerical methods. Combines theoretical ideas along with hands-on experience using appropriate computer software. *Prerequisite: MATH 160.*

MATH 370 Discrete Mathematics (3). The terminology, concepts, and techniques of some areas of discrete mathematics applicable to computer science. Logic and proof techniques, recursion, set theory and counting, relations and functions, groups and codes, graphs. *Prerequisite: MATH 160.*

MATH 374 Linear Algebra (3). Systems of linear equations, vector spaces, independence, bases, dimension, orthogonality, least squares, determinants, eigenvalues and eigenvectors, positive definiteness, computation, linear programming. Continues theoretical ideas with hands-on experience using appropriate software packages. *Prerequisite: MATH 160.*

MATH 346 Mathematical Methods for Physics (3). Survey of mathematical methods applicable to physics. Includes series, complex analysis, ordinary and partial differential equations, and special functions and transforms. *Prerequisite: MATH 162. Recommended: MATH 260.* (NOTE: This is a new course in the Department of Mathematics.)

PHYSICS (PHYS)

PHYS 201 - Physics of Mechanics and Sound (4). 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. *Counts toward the fulfillment of the lower-division General Education requirement in Physical Universe and Its Life Forms. Three hours of lecture and three hours of laboratory. Recommended: High school physics. Prerequisites: Completion of MATH 160 with a minimum grade of C. requirement.*

PHYS 202 - Physics of Electromagnetism and Optics (4). 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. Prerequisites: Completion of PHYS 201 and Math 162 with a minimum grade of C in each.*

PHYS 203 - Modern Physics (4). 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 law 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. Prerequisites: Completion of PHYS 202 with a minimum grade of C.*

PHYS 205 - Physics for the Biological Sciences I (4). A broad coverage of the principles of mechanics, properties of matter and wave motion. The topics 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: High school physics or an introductory college level physics course. Prerequisites: Completion of MATH 160 with a minimum grade of C.*

PHYS 206 - Physics for the Biological Sciences II (4). 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. Prerequisites: Completion of PHYS 201 or PHYS 205 with a minimum grade of C.*

PHYS 280 Introduction to Electronics (3). 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. Prerequisites: PHYS 202. Recommended completion or concurrent: PHYS 203.*

PHYS 301 - Digital Electronics (4). 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. *Three hours of lecture and three hours of laboratory. Prerequisites: PHYS 202 and CS 231 or equivalent with a minimum grade of C.*

PHYS 320 Classical Mechanics (3). Classical mechanics and associated mathematical and numerical techniques: Principles of Newtonian mechanics, 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. *Prerequisites: PHYS 203.*

PHYS 321 Classical Electromagnetism (3). An introduction to the applications of Maxwell's equations and the propagation of EM waves in relation to matter. Topics to be covered include: dielectrics, conductors, plasmas, and waveguides, and selected topics in EM wave radiation, propagation, absorption, transmission, and diffraction. *Three hours of lecture. Prerequisites: PHYS 202, PHYS 203, MATH 162 all with a grade of C or better. Recommended: MATH 346.*

PHYS 323 Quantum Physics (3). A survey of quanta based physical theories, their experimental foundations and applications: quantum physics of atoms, molecules, nuclei and electrons; introduction to condensed matter physics. *Prerequisite: PHYS 203. Recommended: MATH 346.*

PHYS 324 Statistical Mechanics & Thermodynamics(3). Covers the laws of thermodynamics with applications to ideal and non-ideal systems. Includes elementary kinetic theory of gases, entropy, classical and quantum statistical mechanics. Other topics covered may include magnetism and low-temperature physics. *Prerequisites: PHYS 203.*

PHYS 380 Applied Laboratory Techniques (2). 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. Prerequisite: PHYS 203.*

PHYS 402 Computer Interfacing and Control (4). Introduction to the design and use of sensors of various types with digital computer interfaces for data capture and experimental control. Various types of digital communication are studied including 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. Prerequisites: PHYS 301. May not be taken for credit by students who have received credit for PHYS 302.*

PHYS 403 Signals and Systems (3). Introduction to signals and digital signal processing including: fundamentals of signals, signal processing, filter synthesis, discrete-time systems, discrete Fourier transforms and FFT, Z-transforms, sampling, quantization, and image processing. *Prerequisites: PHYS 202.*

PHYS 421 Applied Electromagnetic Waves and Optics (3). A study of the application of electromagnetic principles to electromagnetic waves and optics. Includes radiation and propagation of electromagnetic waves, ray optics, physical optics, optical devices, laser optics, holography, and optics of vision. *Prerequisites: PHYS 321, MATH 162, MATH 346.*

PHYS 422 Applied Solid State Physics (3) (currently PHYS 322, 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. *Prerequisites: PHYS 203, and an upper-division non-GE mathematics course.*

PHYS 423 Quantum Mechanics (3). 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, MATH 346. Recommended: MATH 362.*

PHYS 480 – Advanced Applied Physics Laboratory (2). 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. Prerequisite: PHYS 203, PHYS 280.*

PHYS 499 – Senior Laboratory Thesis (2). 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. *Prerequisite: Consent of the instructor.*