

OFFICE: Physics 131

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Faculty

Emeritus: Burnett, Cottrell, Day, Feher, Goldberg, Lilly, Oseroff, Papin, Piserchio, Roeder, S., Shackelford, Shore, Sweedler, Wallace, Wolter

Chair: Sinha

Professors: Davis, Johnson, Sinha, Torikachvili, Weber

Associate Professors: Anderson, Baljon, Tambasco

Assistant Professors: Kuznetsova, Navarro Perez, Nollett, Sundqvist

Lecturers: Chalmers, Leduc, Mardirossian

Offered by the Department

Master of Arts degree in physics.

Master of Science degree in medical physics.

Master of Science degree in physics.

Major in physics with the B.A. degree in liberal arts and sciences.

Major in physics with the B.S. degree in applied arts and sciences.

Major in chemical physics with the B.S. degree in applied arts and sciences.

Teaching major in physical science in preparation for the single subject teaching credential in science/physical science.

Minor in physics.

Certificate in residency training in radiation therapy physics (refer to the *Graduate Bulletin*).

The Major

The study of physics is considered the foundation of modern science. It has fascinated the finest minds of every age – from Newton to Maxwell, Einstein, Bohr, Schroedinger, Oppenheimer and Schwinger. The study of this diverse field encompasses such areas as optics, electricity, magnetism, the properties of the solid state, atomic structure, nuclear structure, motion, relativity, space and time. Physics also plays a significant role in chemistry, biology, astronomy, and geology, and in the applied sciences of engineering and technology.

Students who become physics majors will be selecting a rewarding and vital career. The great burst of activity during the last 20 years has instilled a new excitement in physics. For example, the invention of the laser in the late 1950s revolutionized the field of optics. These advances stimulated whole new areas in physics applications. Superconductivity has led to the search for a high-temperature superconductor so that electrical power might be transmitted without loss; quantum mechanical tunneling has led to the tunnel diode; and solid state physics brought about the transistor and its successors.

The career opportunities for physics graduates are as diverse as the field itself. They include research and development; management or administration in industrial laboratories or government agencies; technical sales; electronic design; laser instrument research; and secondary teaching.

Impacted Program

The majors in the Department of Physics are impacted. To be admitted to one of the majors in the department, students must meet the following criteria:

- a. Complete preparation for the major;
- b. Complete a minimum of 60 transferable semester units;
- c. Have a minimum cumulative GPA of 2.0.

To complete the major, students must fulfill the degree requirements for the major described in the catalog in effect at the time they are accepted into the premajor at SDSU (assuming continuous enrollment).

Major Academic Plans (MAPs)

Visit <http://www.sdsu.edu/mymap> for the recommended courses needed to fulfill your major requirements. The MAPs website was created to help students navigate the course requirements for their majors and to identify which General Education course will also fulfill a major preparation course requirement.

Physics Major

With the B.A. Degree in Liberal Arts and Sciences

(Major Code: 19021) (SIMS Code: 777702)

All candidates for a degree in liberal arts and sciences must complete the graduation requirements listed in the section of this catalog on "Graduation Requirements." A master plan of the courses taken to fulfill the major must be approved by the undergraduate adviser. No more than 48 units in physics courses can apply to the degree.

A minor is not required with this major.

Preparation for the Major. Physics 195, 195L, 196, 196L, 197, 197L; Chemistry 200; Mathematics 150, 151, 252. (29 units)

Language Requirement. Competency (successfully completing the third college semester or fifth college quarter) is required in one foreign language to fulfill the graduation requirement. Refer to the section of this catalog on "Graduation Requirements."

Graduation Writing Assessment Requirement. Passing the Writing Placement Assessment with a score of 10 or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

Major. A minimum of 34 upper division units to include Physics 311, 317, 350, 354, 357, 360, 400A-400B, 410; Mathematics 342A, 342B.

Physics Major

With the B.S. Degree in Applied Arts and Sciences

(Major Code: 19021)

All candidates for a degree in applied arts and sciences must complete the graduation requirements listed in the section of this catalog on "Graduation Requirements." A master plan of the courses taken to fulfill the major must be approved by the undergraduate adviser.

A minor is not required with this major.

Basic Requirements for all Students

Preparation for the Major. Physics 195, 195L, 196, 196L, 197, 197L; Chemistry 200; Mathematics 150, 151, 252. (29 units)

Graduation Writing Assessment Requirement. Passing the Writing Placement Assessment with a score of 10 or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

Major. A minimum of 46 upper division units to include Physics 311, 317, 350, 354, 357, 360, 400A-400B, 410, 498A, 498B; Mathematics 342A, 342B. In addition, the student must complete the requirements for either one of the following areas:

A. General Physics

(SIMS Code: 777701)

Nine units of elective coursework in physics or related areas. Electives must be approved by the Physics department undergraduate adviser.

B. Modern Optics

(SIMS Code: 777728)

Required: Physics 406, 552, 553.

Chemical Physics Major

With the B.S. Degree in Applied Arts and Sciences

(Major Code: 19081) (SIMS Code: 772801)

All candidates for a degree in applied arts and sciences must complete the graduation requirements listed in the section of this catalog on "Graduation Requirements." A master plan of the courses taken to fulfill the major must be approved by the undergraduate adviser.

A minor is not required with this major.

Preparation for the Major. Physics 195, 195L, 196, 196L, 197, 197L; Chemistry 201, 202, 232, 232L, 251; Mathematics 150, 151, 252. (42 units)

Recommended: A course in computer programming.

Graduation Writing Assessment Requirement. Passing the Writing Placement Assessment with a score of 10 or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

Major. A minimum of 36 upper division units to include Physics 311, 350, 400A, 410; Chemistry 410A-410B, 417, 550; Mathematics 342A, 342B; three units selected from Physics 357, 360, 400B, Chemistry 432, 432L, 457, 510, Physics 538 [or Chemistry 538]; and Research Project: Chemistry 497 (3 units) or Chemistry 498 (3 units) or Physics 498A and 498B (3 units).

Physical Science Major

In preparation for the Single Subject Teaching Credential in Science/Physical Science

With the B.A. Degree in Applied Arts and Sciences

(Major Code: 19011) (SIMS Code: 777303)

All candidates for a degree in applied arts and sciences must complete the graduation requirements listed in the section of the catalog on "Graduation Requirements." Candidates may complete one of their two American Institutions courses at the upper division level or satisfy the California state and local government portion of American Institutions by passing the California Government examination available through the Testing Services office.

A minor is not required for this major.

Preparation for the Major. Africana Studies 140 or Chicana and Chicano Studies 111A or Communication 103; Astronomy 109, 201; Biology 203, 203L, 204, 204L; Chemistry 200, 201; Mathematics 150, 151, 252; Physics 195, 195L, 196, 196L, 197, 197L; Teacher Education 211B (1 unit). (50 units)

Graduation Writing Assessment Requirement. Passing the Writing Placement Assessment with a score of 10 or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

Major. A minimum of 32 upper division units to include Geological Sciences 412; Mathematics 342A; Physics 311, 317, 350, 354, 357, 360, 400A, 499 (History of Science and Technology).

Additional Requirements for Teaching in California. In order to teach science and physics in California public schools, candidates must also complete a fifth-year, post-baccalaureate program to earn a single subject teaching credential. Completion of the physical science major provides the breadth needed for teaching interdisciplinary science in middle school and high school, as well as the depth needed for teaching physics in high school. It also prepares candidates to pass the California Subject Examinations for Teachers (CSET) required for entry into a post-baccalaureate credential program. See the Department of Dual Language and English Learner Education and/or the School of Teacher Education for additional requirements needed to enter a California fifth-year program.

Additional Requirements for Subject Matter Preparation Certification

Satisfactory Grades. At most one course with a C- or lower among the courses listed under Preparation for the Major, and at most one course with a C- or lower among the courses listed under the Major. If a course is repeated, the highest grade will count.

Formative Assessment. Completion of a satisfactory, preliminary portfolio two semesters prior to graduation. Contact the subject matter preparation adviser for information.

Summative Assessment. Completion of a satisfactory, final portfolio and a positive recommendation from the instructor of Physics 357.

Physics Minor

(Minor Code: 19021) (SIMS Code: 777701)

The following courses are prerequisites to the physics minor and do not count toward the 15 units required for the minor. Physics 195, 195L, 196, 196L, 197, 197L; Mathematics 150, 151, 252.

The minor in physics consists of a minimum of 15 units to include Physics 350, 354, 360, 400A; Mathematics 342A.

Courses in the minor may not be counted toward the major, but may be used to satisfy preparation for the major and general education requirements, if applicable. A minimum of six upper division units must be completed in residence at San Diego State University.

Courses (PHYS)

Refer to *Courses and Curricula and University Policies* sections of this catalog for explanation of the course numbering system, unit or credit hour, prerequisites, and related information.

LOWER DIVISION COURSES

NOTE: Maximum credit 12 units for any combination of Physics 180A, 180B, 182A, 182B, 195, 195L, 196, 196L, 197, 197L.

PHYS 180A. Fundamentals of Physics (3)

Prerequisite: Satisfaction of the SDSU Mathematics/Quantitative Reasoning Assessment requirement. Physics 180A is prerequisite to 180B. Recommended: Concurrent registration in Physics 182A.

Mechanics, wave motion, sound, and fluids. Physics 180A not open to students with credit in Physics 195. Biological sciences majors must complete entire sequence of Physics 180A-180B or Physics 195, 196, 197.

PHYS 180B. Fundamentals of Physics (3)

Prerequisite: Satisfaction of the SDSU Mathematics/Quantitative Reasoning Assessment requirement. Physics 180A is prerequisite to 180B. Recommended: Concurrent registration in Physics 182B.

Electricity, magnetism, optics, and modern physics. Presented in a two-semester algebra/trigonometry based sequence. Physics 180B not open to students with credit in Physics 196. Biological sciences majors must complete entire sequence of Physics 180A-180B or Physics 195, 196, 197.

PHYS 182A. Physical Measurements Laboratory (1)

Three hours of laboratory.

Prerequisite: Credit or concurrent registration in Physics 180A.

A laboratory course to accompany Physics 180A-180B. Properties of matter, mechanics, sound, and wave motion. Not open to students with credit in Physics 195L.

PHYS 182B. Physical Measurements Laboratory (1)

Three hours of laboratory.

Prerequisite: Credit or concurrent registration in Physics 180B.

A laboratory course to accompany Physics 180A-180B. Electricity, DC circuits, oscilloscope measurement techniques, electric and magnetic fields, and optics. Not open to students with credit in Physics 196L.

PHYS 195. Principles of Physics (3)

Prerequisites: High school physics or Physics 180A. Mathematics 150 with a minimum grade of C.

Fundamental principles of physics in areas of mechanics and oscillatory motion. Designed for students requiring calculus-based physics.

PHYS 195L. Principles of Physics Laboratory (1)

Three hours of laboratory.

Prerequisite: Credit or concurrent registration in Physics 195.

Experiments in mechanics, wave motion, resonance phenomena using precision air tracks. Not open to students with credit in Physics 182A.

PHYS 196. Principles of Physics (3)

Prerequisites: Physics 195 and Mathematics 151.

Fundamental principles of physics in areas of electricity and magnetism. Designed for students requiring calculus-based physics.

PHYS 196L. Principles of Physics Laboratory (1)

Three hours of laboratory.

Prerequisite: Credit or concurrent registration in Physics 196.

Experiments in DC circuits, AC circuits, electrical resonance, oscilloscope measurement techniques, and electric and magnetic fields. Not open to students with credit in Physics 182B.

PHYS 197. Principles of Physics (3)

Prerequisite: Physics 196.

Fundamental principles of physics in areas of electromagnetic waves, modern physics, optics, relativity, thermodynamics, and wave motion. Designed for students requiring calculus-based physics.

PHYS 197L. Principles of Physics Laboratory (1)

Three hours of laboratory.

Prerequisite: Credit or concurrent registration in Physics 197.

Experiments in optics, lasers, holography, and nuclear counting.

PHYS 296. Experimental Topics (1-4)

Selected topics. May be repeated with new content. See *Class Schedule* for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree.

PHYS 299. Special Study (1-3)

Prerequisites: Consent of department chair and instructor.

Individual study.

UPPER DIVISION COURSES

(Intended for Undergraduates)

PHYS 311. Electronics for Scientists (4)

Three lectures and three hours of laboratory.

Prerequisites: Physics 180B and 182B, or 196 and 196L.

AC and DC circuits, diodes, transistors, conventional and operational amplifiers, analog to digital conversion, pulse and digital electronics. Introduce science majors to modern electronic devices and their utilization in scientific instrumentation.

PHYS 317. Introduction to Computational Physics (3)

One lecture and six hours of laboratory.

Prerequisites: Physics 197 and Mathematics 342A.

Numerical methods applied to a variety of physics topics. Use of computers to solve and plot problems involving differential equations, matrices, root finding, numerical integration.

PHYS 350. Classical Mechanics (3)

Prerequisites: Physics 195 with a minimum grade of C and Physics 197. Credit or concurrent registration in Mathematics 342A.

Newtonian mechanics, gravitation, small oscillations, collisions, motion of rigid bodies, Lagrangian mechanics.

PHYS 354. Modern Physics (3)

Prerequisites: Physics 197 and Mathematics 252 with a grade of C (2.0) or better in each course. Credit or concurrent registration in Mathematics 342A.

Special theory of relativity. Particle properties of electromagnetic radiation, and wave properties of particles. Introduction to quantum theory with applications to atomic structure.

PHYS 357. Advanced Physical Measurements (3)

One lecture and six hours of laboratory.

Prerequisites: Physics 197L, 311, 354, and Chemistry 200.

Stresses both laboratory experiments and techniques of data and error analysis. Experiments are taken from major areas of physics.

PHYS 360. Thermal Physics (3)

Prerequisites: Physics 350, Mathematics 342A, Physics 354 or Chemistry 410A.

Classical thermodynamics and statistical mechanics. Applications of equilibrium thermodynamics. Statistical mechanics, including concepts from probability and statistics. Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein statistics. Applications of statistical mechanics in calculating macroscopic properties of simple systems.

PHYS 400A-400B. Classical Electromagnetism (3-3)

Prerequisites for Physics 400A: Physics 196 with a minimum grade of C; Physics 197 and Mathematics 342A. Physics 400A is prerequisite to Physics 400B.

Electrostatics, magnetostatics, electromagnetic induction, Maxwell's equations, radiation and wave propagation.

PHYS 406. Optics (3)

Prerequisites: Physics 197, 197L, Mathematics 342B.

Reflection, refraction, matrix methods, dispersion, polarization, double refraction, interference, diffraction, Fourier optics, coherence theory, lasers, and holography with applications to optical instruments, wave propagation, and the nature of light.

PHYS 410. Quantum Mechanics (3)

Prerequisites: Physics 350, Mathematics 342B, Physics 354 or Chemistry 410A.

Mathematical and physical foundations of quantum theory in terms of wave and matrix mechanics. Applications to properties of atoms and solids.

PHYS 412. Processes and Inquiry in Physics (4)

Three lectures and two hours of activity.

Prerequisite: Completion of the General Education requirement in Foundations of Learning II.A., Natural Sciences and Quantitative Reasoning.

Investigation of processes of inquiry and rational thinking skills characteristic of physics, focusing on energy transformations, heat transfer and thermodynamics, force and motion, electricity and magnetism, and waves.

PHYS 496. Selected Topics in Physics (1-4)

Prerequisite: Consent of instructor.

Selected topics in classical and modern physics. May be repeated with consent of instructor. See *Class Schedule* for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree. Maximum credit six units.

PHYS 498A. Senior Research (1) Cr/NC

One discussion period and two additional hours per week to be arranged.

Prerequisites: Physics 357 and consent of instructor.

Selection and design of individual research project. Oral and written progress reports.

PHYS 498B. Senior Research (2)

Two discussion periods and four additional hours per week to be arranged.

Prerequisite: Physics 498A.

Laboratory work, progress reports, oral and written final reports.

PHYS 499. Special Study (1-3)

Individual study or laboratory work on a special problem in physics selected by the student. Each student will be assigned a member of the staff who will supervise his/her work. Credit, hours and topics to be arranged in each case. Maximum credit six units.

Physics

UPPER DIVISION COURSES

(Also Acceptable for Advanced Degrees)

PHYS 532. Condensed Matter Physics (3)

Prerequisite: Physics 410 with a grade of C (2.0) or better; or graduate standing.

Elastic, electric, magnetic, optical, and thermal properties of solids. Energy band theory of solids and practical application with metals and semiconductors.

PHYS 538. Polymer Science (3)

(Same course as Chemistry 538)

Prerequisites: Chemistry 200 or 202; and credit or concurrent registration in Chemistry 410B or Physics 360 or Mechanical Engineering 350.

Structure, synthesis, physical properties, and utilities of polymers and biopolymers.

PHYS 552. Modern Optics and Lasers (3)

Prerequisites: Physics 406 with minimum grade of C; credit or concurrent registration in Physics 400B.

Electromagnetic theory, matrix methods of optics, propagation of Gaussian beams, optical resonators, interaction of radiation and atomic systems, theory of laser oscillation, nonlinear optics, specific laser systems, optical detectors, applications of lasers in physics.

PHYS 553. Modern Optics Laboratory (3)

One lecture and six hours of laboratory.

Prerequisites: Physics 357 with minimum grade of C; Physics 406 with minimum grade of C; credit or concurrent registration in Physics 552.

Experiments in various fields of modern optics such as holography, physics of lasers, Fourier transform spectroscopy, Raman spectroscopy, light modulation techniques, fiber optics, spatial filtering, diffraction grating spectroscopy, radiometry, and nonlinear optics.

PHYS 560. Radiological Physics and Dosimetry (3)

Prerequisite: Credit or concurrent registration in Physics 354.

Ionizing radiation fields, interactions of radiation with matter, cavity theory, external radiation dosimetry.

PHYS 564. Nuclear Physics (3)

Prerequisite: Credit or concurrent registration in Physics 410.

Nuclear and elementary particle phenomena including nuclear structure, decay, and radioactivity. Nuclear reactions and devices. Experimental methods and applications.

PHYS 565. Radiobiology and Radiation Safety (3)

Prerequisites: Credit or concurrent registration in Physics 560 and consent of instructor.

Effects of ionizing radiation on physical and biological systems in medical imaging and radiation therapy. Associated radiation safety precautions.

PHYS 567. Nuclear Medicine Physics (3)

Prerequisite: Physics 560.

Physical principles of nuclear medicine and operating principles of nuclear medicine instrumentation. Radionuclide production, dose calibrators, well counters, gamma cameras, SPECT, PET, image quality, tomographic reconstruction, and image processing.

PHYS 570. Relativity (3)

Prerequisites: Physics 354 and 400B.

Relative coordinates, Lorentz transformation, covariant formulation of the laws of physics, applications of special relativity, introduction to curved space time, cosmology.

PHYS 580. Computational Physics (3)

Prerequisites: Physics 354; Computer Engineering 160; and credit or concurrent registration in Physics 400A.

Computer programming for numerical solution of problems in classical mechanics, electromagnetism, optics, and quantum mechanics. Use of Fortran and C programming languages and the UNIX operating system. Incorporation of standard subroutines for linear algebra and differential equations into student written programs.

PHYS 596. Special Topics in Physics (1-4)

Prerequisite: Consent of instructor.

Selected topics in classical and modern physics. May be repeated with the consent of the instructor. See *Class Schedule* for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree. Maximum credit of six units of 596 applicable to a bachelor's degree. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

GRADUATE COURSES

Refer to the *Graduate Bulletin*.
