Physics
In the College of Sciences

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Faculty
Chair: Sinha
Professors: Davis, Johnson, Papin, Sweedler, Torikachvili, Weber
Associate Professors: Anderson, Bajon, Tambasco
Assistant Professor: Kuznetsova
Lecturers: Bass, Chalmers, Mardirossian
Adjunct: Bendall, Jani, Mueller

Offered by the Department
Master of Arts degree in physics. 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.

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 premajors 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.” Individual master plans for each student are filed with both the physics undergraduate adviser and the Office of Advising and Evaluations. 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, 330, 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.” Individual master plans for each student are filed with both the physics undergraduate adviser and the Office of Advising and Evaluations. 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, 330, 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.” Individual master plans for each student are filed with the physics and chemistry undergraduate advisers and the Office of Advising and Evaluations.

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 this catalog on “Graduation Requirements.” Candidates may complete one of the two American Institutions courses at the upper division level or satisfy the California state and local government portion of American of their two American Institutions courses at the upper division level or catalog on “Graduation Requirements.” Candidates may complete one course with a C- or lower among the courses listed under Preparation for the Major. 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).

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.
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 wave motion, sound, electromagnetic waves, optics, relativity, and modern physics. 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 with a minimum grade of C. 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.

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. (Formerly numbered Natural Science 412.)

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

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.
UPPER DIVISION COURSES  
(Also Acceptable for Advanced Degrees)

PHYS 538. Polymer Science (3)  
(Same course as Chemistry 538)  
Prerequisites: Chemistry 200 or 202; and Chemistry 410B or Physics 360 or Mechanical Engineering 350.  
Structure, synthesis, physical properties, and utilities of polymers.

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: Physics 354.  
Ionizing radiation fields, interactions of radiation with matter, cavity theory, external radiation dosimetry.

PHYS 561. Nuclear Instrumentation (3)  
One lecture and six hours of laboratory.  
Prerequisites: Physics 311 and 560.  
Radiation detection, measurement, and spectroscopy, ionization chambers, GM and proportional counters, scintillation and semiconductor detectors, and thermoluminescent 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 formation 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. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

GRADUATE COURSES  
Refer to the Graduate Bulletin.

Policy Studies in Language and Cross-Cultural Education  
Refer to “Dual Language and English Learner Education” in this section of the catalog.