PHYSICS

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**Faculty Early Retirement Program*

Programs Offered

Bachelor of Science in Physics

Bachelor of Arts in Physics

Minor in Physics

Teaching Credential Preparation

Physics is the most fundamental of all the scientific disciplines. Ranging from the applied to the abstract, from the infinitesimal to the infinite, and from quarks to the cosmos, the study of physics seeks to explain all the complicated phenomena in the natural world by providing a description of these phenomena in terms of a few basic principles and laws.

Physicists also use their knowledge of fundamental principles to solve concrete problems. Problems in understanding and utilizing the properties of semiconductors and other materials; in designing and building lasers, photonics, and telecommunications devices; and in designing and using instrumentation such as adaptive optics for astrophysics, are typically solved using the techniques of physics. Such applied physics problems often have a significant overlap with topics and techniques in engineering and computational physics. Indeed, many of the department's graduates are currently employed in engineering or computationally oriented positions.

In their most abstract work, physicists seek a unified mathematical description of the four known forces of nature (gravitation, electrical magnetism, and the weak and strong nuclear forces). This quest for the "Theory of Everything" eluded Einstein and is continued today by many physicists, including those who study superstring theory. The ultimate goal is to correctly predict the fundamental forces and the masses and interactions of the elementary particles from which all matter is formed.

The department offers a traditional, mathematically rigorous program leading to a B.S. in physics; a more applied curriculum leading to a B.S. in physics with a concentration in applied physics; and a flexible B.A. program with two advisory plans (algebra and trigonometry or calculus). All programs stress fundamental concepts and techniques, offer an unusually rich laboratory experience and intensive use of computers, and require a capstone course as a culminating experience. Capstone projects may include experimental design, instructional design, or undergraduate research—personalized and unique opportunities to demonstrate the skills and knowledge acquired in the major.

The department is housed in Darwin Hall, which was remodeled in 2006 and is well-equipped with lower-division teaching laboratories and facilities for intermediate and advanced laboratory courses, undergraduate research, special studies and capstone projects. The Darwin facilities include thin film fabrication systems such as sputtering, thermal evaporation, chemical vapor deposition and electrodeposition, a Hall measurement system, a 17-Tesla superconducting magnet system, an adaptive optics and astronomical instrumentation development laboratory, and a nuclear low-level counting laboratory. Physics majors also use the multidisciplinary Keck Microanalysis Laboratory in Salazar Hall which includes a scanning electron microscope, atomic force microscopes, an x-ray diffractometer, and a confocal microscope.

A substantial program in undergraduate astronomy includes many courses, listed in this catalog under Astronomy, which may be included in the B.A. or B.S. degree programs in physics. The department operates a teaching observatory on the SSU campus and a NASA-funded remotely operated research observatory at a darker site in northern Sonoma County. The department is also developing a new observatory at the Galbreath Wildlands Preserve in southern Mendocino County. Students are strongly encouraged to use all of the above facilities for special studies, undergraduate research, and capstone projects.

Careers in Physics

For information on what you can do with a bachelor's degree in physics, follow links from: http://phys-astro.sonoma.edu

Bachelor of Science in Physics

The B.S. program is a thorough introduction to the principles of physics, providing a strong foundation for graduate study or industrial research. It is also intended for those students who wish to prepare for interdisciplinary studies on the graduate level in fields such as astronomy, atmospheric science, biophysics, environmental science, geophysics, materials science, and physical oceanography.

Degree Requirements	Units
General education	51
Major requirements (may include 5 units in GE)	46
Supporting courses (may include 4 units in GE)	26
Electives	1-10
Total units needed for graduation	124

Major Core Requirements

PHYS 114 Introduction to Physics I (may be applied to GE)	4
PHYS 116 Introductory Laboratory Experience (may be applied to GE)	1
PHYS 214 Introduction to Physics II	4
PHYS 216 Introductory Laboratory	1
PHYS 313 Electronics	3
PHYS 313L Electronics Laboratory	1
PHYS 314 Introduction to Physics III	4
PHYS 320 Analytical Mechanics	3
PHYS 325 Introduction to Mathematical Physics	3
PHYS 340 Light and Optics	3
PHYS 366 Intermediate Experimental Physics	3
PHYS 381 Computer Applications for Scientists	2
PHYS 430 Electricity and Magnetism	3
PHYS 450 Statistical Physics	2
PHYS 460 Quantum Physics	3
Total units in the major core	40

Major Electives (Advanced)

6 Units selected from the following (must include at least one *Capstone Course)

ASTR 380 Astrophysics: Stars (3)

ASTR 482 Advanced Observational Astronomy (2)

*ASTR 492 Instructional Design Project (2)

ASTR 495 Special Studies (1-4)

*ASTR 497 Undergraduate Research in Astronomy (2)

PHYS 445 Photonics (3)

PHYS 466 Advanced Experimental Physics (3)

PHYS 475 Physics of Semiconductor Devices (3)

*PHYS 492 Instructional Design Project (2)

*PHYS 493 Senior Design Project (2)

PHYS 494 Physics Seminar (1)

PHYS 495 Special Studies (1-4)

*PHYS 497 Undergraduate Research in Physics (2)

Certain selected-topics courses, ASTR or PHYS 396, may be approved by the advisor.

Total units in the advanced electives	6
Total units in the major	46

Required Supporting Courses

MATH 161 Calculus I (3 units may be applied in GE)	4
MATH 211 Calculus II	4
MATH 241 Differential Equations with Linear Algebra	4
MATH 261 Multivariable Calculus	4
CHEM 115AB General Chemistry (1 unit may be applied in GE) or CHEM 125 AB Honors General Chemistry	10
Total units in supporting courses	26
Total units in the major and supporting courses (9 may be applied in GE)	72

Sample Four-year Program for Bachelor of Science in Physics

The sequential nature of the physics curriculum necessitates an early start with major requirements and the distribution of general education courses over four years.

FRESHMAN YEAR:: 31 Units

Fall Semester (15 Units)	Spring Semester (16 Units)
CHEM 115A (5)	CHEM 115B (5)
MATH 161 (4)	MATH 211 (4)
ENGL 101 (3) (GE A2)	PHYS 114 (4)
Elective (2)	PHYS 116 (1)
PHYS 494 (1) (Recommended)	Elective (2)

SOPHOMORE YEAR:: 31 Units

Fall Semester (15 Units)	Spring Semester (16 Units)
MATH 261 (4)	MATH 241 (4)
PHYS 214 (4)	PHYS 313 (3)
PHYS 216 (1)	PHYS 313L (1)
GE (3)	GE (3)
GE (3)	GE (3)
	Elective (2)

JUNIOR YEAR:: 30 Units

Fall Semester (15 Units)	Spring Semester (15 Units)
PHYS 325 (3)	PHYS 320 (3)
PHYS 314 (4)	PHYS 340 (3)
PHYS 381 (2)	PHYS 366 (3)
GE (3)	GE (3)
GE (3)	GE (3)

SENIOR YEAR:: 32 Units

Fall Semester (16 Units)	Spring Semester (16 Units)
PHYS 450 (2)	PHYS 430 (3)
PHYS 460 (3)	PHYS Elective (2)
PHYS Elective (3)	GE (3)
GE (3)	GE (3)
GE (3)	GE (3)
Elective (2)	Elective (2)

TOTAL UNITS:: 124

See your advisor to discuss acceptable physics electives and when they will be offered. Twelve of the 51 units of GE are met by required courses listed here (3 each in areas A2, B1, B3, and B4).

Applied Physics Concentration

Students may earn a B.S. in physics with a concentration in applied physics. This program is intended for those students who desire an emphasis on laboratory work. It provides a rigorous, yet slightly less theoretical course of study, and a greater selection of hands-on electives. It is a good choice for students who wish to continue their studies in graduate engineering programs, or who wish to work in industry in engineering or computationally oriented positions.

Degree Requirements	Units
General education	51
Major requirements (may include 5 in GE)	48
Supporting courses (may include 4 in GE)	17
Electives	8-17
Total units needed for graduation	124

Major Core Requirements

PHYS 114 Introduction to Physics I (may be applied to GE)	4
PHYS 116 Introductory Laboratory Experience (may be applied to GE)	1
PHYS 214 Introduction to Physics II	4
PHYS 216 Introductory Laboratory	1
PHYS 313 Electronics I	3
PHYS 313L Electronics I Laboratory	1
PHYS 314 Introduction to Physics III	4
PHYS 325 Introduction to Mathematical Physics	3
PHYS 340 Light and Optics	3
PHYS 366 Intermediate Experimental Physics	3
PHYS 381 Computer Applications for Scientists	2
PHYS 430 Electricity and Magnetism	3
PHYS 450 Statistical Physics	2
PHYS 460 Quantum Physics	3
PHYS 475 Physics of Semiconductor Devices	3
Total units in the major core	40

Major Electives (Advanced)

8 units selected from the following: (must include at least one *capstone course)

ASTR 482 Advanced Observational Astronomy (2)
*ASTR 492 Instructional Design Project (2)
ASTR 495 Special Studies (1-4)
*ASTR 497 Undergraduate Research in Astronomy (2)
PHYS 320 Analytical Mechanics (3)
PHYS 445 Photonics (3)
PHYS 466 Advanced Experimental Physics (3)
*PHYS 492 Instructional Design Project (2)
*PHYS 493 Senior Design Project (2)
PHYS 494 Physics Seminar (1)
PHYS 495 Special Studies (1-4)
*PHYS 497 Undergraduate Research in Physics (2)

Certain selected topics courses, ASTR or PHYS 396, may be approved by the advisor.

Total units in the major electives 8

Total units in the major 48

Required Supporting Courses

MATH 161 Calculus I (3 units may be applied in GE)	4
MATH 211 Calculus II	4
MATH 261 Multivariable Calculus	4
CHEM 115A General Chemistry (1 unit may be applied in GE) or CHEM 125A Honors General Chemistry	5
Total units in supporting courses	17
Total units in the major and supporting courses (9 may be applied in GE)	65

Sample Four-year Program for Bachelor of Science in Physics with Concentration in Applied Physics

The sequential nature of the physics curriculum necessitates an early start with major requirements and the distribution of general education courses over four years.

FRESHMAN YEAR:: 30 Units

Fall Semester (15 Units)	Spring Semester (15 Units)
CHEM 115A (5)	MATH 211 (4)
MATH 161 (4)	PHYS 114 (4)
ENGL 101 (3) (GE A2)	PHYS 116 (1)
Elective (2)	GE (3)
PHYS 494 (1) (recommended)	GE (3)

SOPHOMORE YEAR:: 31 Units

Fall Semester (15 Units)	Spring Semester (16 Units)
MATH 261 (4)	PHYS 313 (3)
PHYS 214 (4)	PHYS 313L (1)
PHYS 216 (1)	GE (3)
GE (3)	GE (3)
GE (3)	GE (3)
	GE (3)

JUNIOR YEAR:: 31 Units

Fall Semester (15 Units)	Spring Semester (16 Units)
PHYS 325 (3)	PHYS 340 (3)
PHYS 314 (4)	PHYS 366 (3)
PHYS 381 (2)	PHYS Elective (3)
GE (3)	GE (3)
Elective (3)	Elective (4)

SENIOR YEAR:: 32 Units

Fall Semester (16 Units)	Spring Semester (16 Units)
PHYS 450 (2)	PHYS 430 (3)
PHYS 460 (3)	PHYS 475 (3)
PHYS Elective (2)	PHYS Elective (2)
GE (3)	GE (3)
Elective (3)	GE (3)
Elective (3)	Elective (2)

TOTAL UNITS:: 124

See your advisor to discuss acceptable physics electives and when they will be offered. Twelve of the 51 units of GE are met by required courses listed here, (3 each in areas A2, B1, B3, and B4).

Bachelor of Arts in Physics

The B.A. program allows considerable flexibility for the student who wishes to study physics as part of a liberal arts education. Two advisory plans are offered:

Bachelor of Arts in Physics with Advisory Plan C

This plan uses calculus. Students who choose this, the more popular B.A. advisory plan, have the prerequisites to take nearly all of the courses in the department. They find employment in scientific and engineering fields. Some go on to graduate school in interdisciplinary sciences. This degree program is appropriate for those who wish to earn a California Science Teaching Credential with a concentration in Physics.

Degree Requirements	Units
Major requirements (may include 5-6 in GE)	34-38
Required area of concentration	12
Supporting courses (may include 3 in GE)	12
General education	51
General electives	7-19
Total units needed for graduation	120

Major Core Requirements

PHYS 114 Introduction to Physics I (may be applied to GE)	4
PHYS 116 Introductory Laboratory Experience (may be applied to GE)	1
PHYS 214 Introduction to Physics II	4
PHYS 216 Introductory Laboratory	1
PHYS 314 Introduction to Physics III	4
PHYS 340 Light and Optics	3
Choose one of the following two programming courses:	2-4
PHYS 381 Computer Applications for Scientists (2)	
CS 115 Programming I (4)	
Capstone course: One of the following	2
ASTR 492 Instructional Design Project (2)	
ASTR 497 Undergraduate Research in Astronomy (2)	
PHYS 492 Instructional Design Project (2)	
PHYS 493 Senior Design Project (2)	
PHYS 497 Undergraduate Research in Physics (2)	
The major must include a minimum of 24 upper-division units in physics and astronomy, so, with an advisor, choose 13-15 units in additional upper-division physics and astronomy courses.	13-15
Total units in the major core	34-38

Required Area Of Concentration

Courses in one other field, chosen in consultation with an advisor.

Total units in area of concentration 12

Supporting Courses

MATH 161 Calculus I (3 units may be applied in GE)	4
MATH 211 Calculus II	4
MATH 261 Multivariable Calculus	4
Total units in supporting courses	12
Total units in the major and supporting courses (8-9 may be applied in GE)	58 - 62

Sample Four-year Program for Bachelor of Arts in Physics with Advisory Plan C

The sequential nature of the physics curriculum necessitates an early start with major requirements and the distribution of general education courses over four years.

FRESHMAN YEAR:: 31 Units

Fall Semester (16 Units)	Spring Semester (15 Units)
MATH 161 (4)	MATH 211 (4)
ENGL 101 (3) (GE A2)	PHYS 114 (4)
GE (3)	PHYS 116 (1)
GE (3)	GE (3)
GE (3)	GE (3)

SOPHOMORE YEAR:: 30 Units

Fall Semester (15 Units)	Spring Semester (15 Units)
MATH 261 (4)	PHYS Elective (3)
PHYS 214 (4)	Elective (3)
PHYS 216 (1)	GE (3)
GE (3)	GE (3)
GE (3)	Elective (3)

JUNIOR YEAR:: 30 Units

Fall Semester (15 Units)	Spring Semester (15 Units)
PHYS 314 (4)	PHYS 340 (3)
PHYS 381 (2)	PHYS Elective (3)
Area of Concentration* (3)	Area of Concentration* (3)
GE (3)	GE (3)
GE (3)	Elective (3)

SENIOR YEAR:: 29 Units

Fall Semester (15 Units)	Spring Semester (14 Units)
PHYS Elective (3)	Capstone Course (2)
Area of Concentration* (3)	Area of Concentration* (3)
GE (4)	PHYS Elective (4)
Electives (5)	Electives (5)

TOTAL UNITS:: 120

**Area of Concentration = 12 units in one other subject. Eleven of the 51 units of GE are met by required courses listed here (in areas A2, B1, B3, and B4). (One more can be met with a physics elective.)*

Bachelor of Arts in Physics with Advisory Plan T

This plan uses algebra and trigonometry. Students may select from upper-division courses, appropriate to careers as science or technical writers, scientific sales personnel, technicians, programmers, or other technical specialists. There is opportunity to take courses that lead to careers in the health sciences or environmental fields. This degree program is appropriate for those who wish to earn a California Multiple Subject Teaching Credential. Advisory Plan T is often taken as part of a double major.

Degree Requirements	Units
Major requirements (may include 6 in GE)	32-36
Required area of concentration	12
Supporting course (may include 3 in GE)	4
General education	51
General electives	17-30
Total units needed for the degree	120

Major Core Requirements

PHYS 209AB General Physics Laboratory	2
PHYS 210AB General Physics	6
Choose one of the following two courses in modern physics or astronomy:	3-4
ASTR 305 Frontiers in Astronomy (3)	
PHYS 314 Introduction to Physics III (4)	
Choose one of the following two courses in optics:	3
PHYS 340 Light and Optics (3)	
PHYS 342 Light and Color (3)	
An approved course in computer applications, e.g., PHYS 381 (2):	2-4
Capstone course: One of the following:	2
ASTR 492 Instructional Design Project (2)	
ASTR 497 Undergraduate Research in Astronomy (2)	
PHYS 492 Instructional Design Project (2)	
PHYS 493 Senior Design Project (2)	
PHYS 497 Undergraduate Research in Physics (2)	
The major must include a minimum of 24 upper-division units in physics and astronomy; so, with an advisor, choose 13-16 units in additional upper-division physics and astronomy courses.	13-16
Total units in the major core	32-36

Required Area Of Concentration

Courses in one other field chosen in consultation with an advisor.

Total units in area of concentration	12

Supporting Course

MATH 107 Pre-calculus Mathematics (3 units may be applied in GE):	4
Total units in supporting course	4
Total units in the major	48-52

Sample Four-year Program for Bachelor of Arts in Physics with Advisory Plan T

The sequential nature of the physics curriculum necessitates an early start with major requirements and the distribution of general education courses over four years.

FRESHMAN YEAR:: 30 Units

Fall Semester (15 Units)	Spring Semester (15 Units)
MATH 107 (4)	PHYS 209A (1)
ENGL 101 (3) (GE A2)	PHYS 210A (3)
GE (3)	GE (3)
GE (3)	GE (3)
Elective (2)	GE (3)
	Elective (2)

SOPHOMORE YEAR:: 31 Units

Fall Semester (15 Units)	Spring Semester (16 Units)
PHYS 209B (1)	PHYS Elective (4)
PHYS 210B (3)	Elective (3)
GE (3)	GE (3)
GE (3)	GE (3)
GE (3)	GE (3)
Elective (2)	

JUNIOR YEAR:: 30 Units

Fall Semester (15 Units)	Spring Semester (15 Units)
ASTR 305 (3)	PHYS 342 (3)
PHYS Elective (3)	PHYS Elective (3)
Area of Concentration* (3)	Area of Concentration* (3)
GE (3)	GE (3)
Elective (3)	Elective (3)

SENIOR YEAR:: 29 Units

Fall Semester (15 Units)	Spring Semester (14 Units)
PHYS Elective (3)	PHYS Elective (2)
PHYS Elective (3)	Area of Concentration* (3)
Area of Concentration* (3)	Elective (3)
Elective (3)	Elective (3)
Elective (3)	Elective (3)

TOTAL UNITS:: 120

**Area of concentration = 12 units in one other subject. Twelve of the 51 units of GE are met by required courses listed here (in areas A2, B1, B3, and B4).*

Minor in Physics

Completion of a minimum of 20 units in physics courses, including not more than one first course or more than one second course, constitutes a minor in physics. (First courses are PHYS 100, 210A, and 114, and their equivalents taught elsewhere. Second courses are PHYS 210B, 214, and their equivalents.) Interested students should consult with the advisor in the Department of Physics and Astronomy.

Teaching Credential Preparation

See the Teaching Credential Preparation in Science Courses section of this catalog or contact the department advisor.