Physics and Astronomy

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Admission to Degree Program
All degree programs in the Department of Physics and Astronomy are open enrollment. However, special limitations apply for teaching majors.

The Discipline
Over the centuries physicists and astronomers have studied the fundamental principles that govern the structure and dynamics of matter and energy in the physical world, from subatomic particles to the cosmos. Physicists also apply this understanding to the development of new technologies. For example, physicists invented the first lasers and semiconductor electronic devices.

Physics and astronomy students learn to approach complex problems in science and technology from a broad background in mechanics, electricity and magnetism, statistical and thermal physics, quantum mechanics, relativity, and optics. The tools they develop at BYU include problem solving by mathematical and computational modeling, as well as experimental discovery and analysis. All students gain professional experience in a research, capstone, or internship project, usually in close association with faculty. Together these experiences can provide excellent preparation for employment or for graduate studies in physics, other sciences, engineering, medicine, law, or business.

Most physicists and astronomers work in research and development in industrial, government, or university labs to solve new problems in technology and science. They also share the beauty discovered in our physical universe by teaching in high schools, colleges, and universities.

Career Opportunities
A degree in physics and astronomy can provide:
1. Preparation for those who intend to enter industrial or governmental service as physicists or astronomers.
2. Education for those who intend to pursue graduate work in physics or astronomy.
3. Education in the subject matter of physics for prospective teachers of the physical sciences.
4. Undergraduate education for those who will pursue graduate work in the professions: business (e.g., an MBA), law, medicine, etc.
5. Fundamental background for other physical sciences and engineering, in preparation for graduate study in these fields.
6. Physics fundamentals required by the biological science, medical, dental, nursing, and related programs.

Graduation Requirements
To receive a bachelor’s degree a student must fill three groups of requirements: (1) general education requirements; (2) university requirements; and (3) major requirements.

General Education Requirements
Students should contact their college advisement center for information about general education courses that will also fill major requirements.
Languages of Learning

Precollege Math (zero to one course) ............... 0–3.0 hours  
(or Math ACT score of at least 22)               0–3.0
First-Year Writing (one course) .................. 3.0
Advanced Writing (one course) .................... 3.0
Advanced Languages/Math/Music (one to four courses) 3–20.0

Liberal Arts Core

Biological Science (one to two courses) ........... 3–6.0
Physical Science (one to two courses) ............. 3–7.0
American Heritage (one to two courses) .......... 3–6.0
Wellness (one to three courses) .................... 1.5–2.0
Civilization (two courses) ........................ 6.0

Arts and Sciences Electives

Arts and Letters (one course) ........................... 3.0
Natural Sciences (one course) .......................... 3–4.0
Social and Behavioral Sciences (one course) ....... 3.0

Note 1: For a complete list of courses that will fill each GE category, see the General Education section of the current class schedule.

Note 2: Additional information about general education requirements can be found in the General Education section of the current class schedule or this catalog.

Minimum University Requirements

Religion ........................................... 14.0
Residency ......................................... 30.0
Hours needed to graduate .......................... 120.0
Cumulative GPA must be at least 2.0.

Note: See the Graduation section of this catalog for more information.

Major Requirements

Complete the major requirements listed under one of the following undergraduate degree programs.

Undergraduate Programs and Degrees

BA  Physics Teaching
BS  Applied Physics
     Emphases:
           Computer Science
           Selected Options
BS  Physics
BS  Physics-Astronomy
Minors Astronomy
Physics
Physics Teaching

Students should see their college advisement center for help or information concerning the undergraduate programs.

Graduate Programs and Degrees

MS  Physics
PhD  Physics
PhD  Physics and Astronomy

For more information see the BYU 2003–2004 Graduate Catalog.

General Information

1. It is recommended that a student complete the following courses in high school:
   3 units of English
   1 unit of physical science, either chemistry or physics.
   4 units of mathematics, consisting of algebra, geometry, trigonometry, and calculus. This should qualify students to begin college mathematics with Math 113, Calculus 2.

   Because mathematics provides the foundation for all work in the physical and mathematical sciences, high school preparation in this subject is of particular importance.

2. Students in physics should take mathematics beginning the first semester of the freshman year. Physics majors should ordinarily begin with Math 113. If preparation is inadequate, students might wish to enter the university during the spring or summer term and bring their mathematics preparation to the point where they can take Math 113 concurrently with Phscs 121 during the fall semester.

3. Students are strongly urged to learn to use a computer, including some knowledge of programming.

BA Physics Teaching (73.5–75.5 hours*, including licensure hours)

Major Requirements

1. No D credit is allowed in major courses.

2. Contact the Education Advisement and Certification Office for entrance requirements into the licensure program.

3. A teaching minor is not required for licensure. However, it is strongly recommended.

4. Complete the following:
   Note: Phscs 191 should be taken early in the student’s schedule.

5. Complete one course from the following:
   Hist 311.
   Phil 423.
   Phscs 314.

6. Complete the following:
   Math 112, 113, 302.

7. Complete the following:
   Math 303, 334.

8. Complete an additional 9 hours from the following or any 300-, 400-, or 500-level physics course not already taken. At least 6 hours must be upper-division physics courses (Phscs 321 and 471 are highly recommended):
   Phscs 137, 167, 281.

9. Complete the Professional Education Component (28–29 hours). See Secondary Education in the Teacher Education section of this catalog for licensure requirements.

Recommended Courses

Chem 105, 106.

*Hours include courses that may fulfill GE or university requirements.

BS Applied Physics: Computer Science Emphasis (63.5–67.5 hours*)

Major Requirements

1. No D credit is allowed in major courses.

2. Complete the following:
   Note: Phscs 191 should be taken early in the student’s schedule.

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3. Complete one of the following options:
   Either Math 113, 302
   Or Math 113, 214, 343.

4. Complete one course from the following:
   Math 303, 334.

5. Complete the following:
   CS 142, 235, 236, 240.

6. Complete one course from the following:
   CS 124, 224, 252, 324, 330.
   ECEn 124, 224, 324, 450.
   Phscs 513R.

7. Complete one course from the following:
   Phscs 360, 427, 442, 451, 471, 517, 545, 561, 571, 585.

8. Complete a capstone project, including the following:
   a. Meet with department applied physics capstone project
      coordinator early in the junior year or before to obtain
      information about projects and procedures.
   b. Complete 2 hours of the following:
      Phscs 492R.

*Hours include courses that may fulfill GE or university requirements.

BS Applied Physics: Selected Options Emphasis
(58.5–61.5 hours*)

Major Requirements
1. No D credit is allowed in major courses.
2. Consult with a faculty advisor as early as possible to choose electives.
3. Complete the following:
   Phscs 121, 123, 150, 191, 220, 222, 230, 250, 318, 321, 330,
   340, 350, 360, 430, 441.
   Note: Phscs 191 should be taken early in the student’s schedule.
4. Complete one course from the following:
   ECEn 460.
   Phscs 442, 471.
5. After gaining department chair’s approval of courses selected
   to define an option, complete an additional 12 hours of
   electives (cannot include any courses already taken above).
   These 12 hours must consist of a coherent set of upper-division
   courses with an identified educational goal. Some standard
   options are available from the department, including
   microelectronics and biomedical physics.
6. Complete one of the following options:
   Either Math 113, 302
   Or Math 113, 214, 343.
7. Complete one course from the following:
   Math 303, 334.
8. Complete a capstone project, including the following:
   a. Meet with department applied physics capstone project
      coordinator early in the junior year or before to obtain
      information about projects and procedures.
   b. Complete 2 hours of the following:
      Phscs 492R.

*Hours include courses that may fulfill GE or university requirements.

BS Physics (58.5–61.5 hours*)

Major Requirements
1. No D credit is allowed in major courses.
2. Complete the following:
   Phscs 121, 123, 150, 191, 220, 222, 230, 250, 318, 321, 330,
   Note: Phscs 191 should be taken early in the student’s schedule.
3. Complete one of the following options:
   Either Math 113, 302
   Or Math 113, 214, 343.
4. Complete one course from the following:
   Math 303, 334.
5. Complete a senior thesis, including the following:
   a. Meet with department undergraduate research coordinator
      early in the junior year or before to obtain information
      about research projects and senior thesis procedures.
   b. Complete 2 hours of the following:
      Phscs 498R, 499R.

Recommended Course
   Chem 105.
*Hours include courses that may fulfill GE or university requirements.

BS Physics-Astronomy (60.5–63.5 hours*)

Major Requirements
1. No D credit is allowed in major courses.
2. Complete the following:
   Phscs 121, 123, 150, 191, 220, 222, 227, 228, 230, 250, 318,
   Note: Phscs 191 should be taken early in the student’s schedule.
3. Complete one of the following options:
   Either Math 113, 302
   Or Math 113, 214, 343.
4. Complete one course from the following:
   Math 303, 334.
5. Complete a senior thesis, including the following:
   a. Meet with department undergraduate research coordinator
      early in the junior year or before to obtain information
      about research projects and senior thesis procedures.
   b. Complete 2 hours of the following:
      Phscs 498R, 499R.

Recommended Course
   Chem 105.
*Hours include courses that may fulfill GE or university requirements.

Minor Astronomy (26 hours*)

Minor Requirements
   Complete the following:
   Phscs 121, 227, 228, 329, 427, 428.
   Math 112, 113.
*Hours include courses that may fulfill GE or university requirements.
Minor Physics (23 hours*)

Minor Requirements
Complete the following:
- Phscs 121, 123, 150, 220, 222, 250, 340.
- Math 112, 113.

*Hours include courses that may fulfill GE or university requirements.

Minor Physics Teaching (25 hours*)

Minor Requirements
Complete the following:
- Phscs 121, 123, 150, 220, 222, 250, 314.
- Math 112, 113.

*Hours include courses that may fulfill GE or university requirements.

Physics and Astronomy (Phscs)

Undergraduate Courses

101. Fundamentals of Physics. (3:3:0) F
Principles of classical and modern physics as they relate to current concepts of our physical environment.

Applied physics course not requiring calculus. Topics include mechanics, heat, wave motion, sound.

Continuation of Phscs 105. Topics include electricity and magnetism, atomic and nuclear physics, and optics.

107. Introductory Applied Physics Laboratory. (1:0:3) F, W, Sp Prerequisite: Phscs 105 or concurrent enrollment.

108. Introductory Applied Physics Laboratory. (1:0:3) F, W, Su Prerequisite: Phscs 106 or concurrent enrollment.

Newtonian mechanics. Weekly lab.

Waves, thermal physics, optics, special relativity, and introduction to modern physics. Weekly lab.

127. Descriptive Astronomy. (3:3:0.5) F, W, Sp, Su Honors and Independent Study also.
Nonmathematical presentation of knowledge of the content and history of the cosmos, frequently using observatory and planetarium.

137. Introduction to the Atmosphere and Weather. (3:3:0) F, W Prerequisite: PhSy 100 or equivalent.
Nonmathematical introduction to characteristics of the atmosphere, emphasizing structure and dynamic behavior, including the environmental impact of man.

150. Introduction to Experimental Physics 1. (1:1:2) F, W, Sp Prerequisite: Phscs 123 or concurrent enrollment.
Using laboratory equipment, sources of uncertainty, statistical analysis of data, curve fitting, computer data acquisition, measurements of motion, electrical measurements.

167. Descriptive Acoustics of Music and Speech. (3:3:0) F, W, Sp Prerequisite: PhSy 100 or equivalent.
Introductory acoustics course, emphasizing physical principles underlying production and perception of music and speech.

191. Introduction to Physics Careers and Research. (0.5:1:0) F
Survey of BYU undergraduate physics and astronomy programs, careers in physics and astronomy, and current physics and astronomy research. Take first semester after registered as physics major.

198. Physics and Mathematics Review. (1:2:0) F 1st blk. Prerequisite: Phscs 121; Math 113 or concurrent enrollment.
Review of mathematics and introductory physics for returning missionaries and others returning after a significant break.

220. Principles of Physics 3. (3:3:1) F, W, Sp Prerequisite: Phscs 121 or equivalent; Math 113 or equivalent.
Electricity and magnetism. Weekly lab.

222. Modern Physics. (3:3:0) F, W, Su Prerequisite: Phscs 121, 123, 220.
Quantum physics, atoms, molecules, condensed matter, nuclei, elementary particles, and selected topics in contemporary physics.

227. Solar System Astronomy. (3:3:0) F Prerequisite: Phscs 121, 123; Math 113 or concurrent enrollment.
Physics of light and matter, Newton’s laws, solar-system dynamics, and planetary surfaces and atmospheres.

Stellar atmospheres, stellar interiors, stellar evolution, interstellar matter, galactic structure, external galaxies, and cosmology.

230. Computational Physics Lab 1. (1:0:3) F, W Prerequisite: Phscs 220 or concurrent enrollment.
Numerical and symbolic differentiation, integration, and differential equations, using Maple. Applications in mechanics, optics, and special relativity.

250. Introduction to Experimental Physics 2. (1:1:2) F, W, Su Prerequisite: Phscs 150 or exposure to programming in LabView.
Electronic devices and measurements, transducers, time and frequency response, optical and heat experiments, nonlinear curve fitting, designing computer interfacing applications.

Introduction to physics of solids, including laboratory experience.


Special topics in physics for undergraduate physics majors.

314. (Phscs-Hist 311–Phil 423) History and Philosophy of Science. (3:3:0) F Prerequisite: PhSy 100 or instructor’s consent. Scientific explanation, concepts, and models. Philosophical assumptions and criteria for theory selection, as exemplified by historical development of basic ideas in science.

318. Introduction to Classical Field Theory. (3:3:0) F, W, Sp Prerequisite: Phscs 230; Math 303 or 334 or concurrent enrollment.
Classical equations of physical fields; algebra of complex variables; applying Fourier analysis, Fourier transforms, and orthogonal functions.

Newton’s laws applied to particles and systems of particles, including rigid bodies. Conservation principles and Lagrange’s and Hamilton’s equations.
329. Observational Astronomy. (3:2:4) W Prerequisite: Phscs 127
or 227 and 228.
Basic techniques of observational astronomy, emphasizing
practical experience in optical data acquisition and analysis.
330. Computational Physics Lab 2. (1:0:3) F, Sp Prerequisite: Phscs
230; 321 or concurrent enrollment; Math 303 or 334 or equivalent.
Numerical solution of ordinary differential equations, linear
algebra and eigenvalues, chaos theory. Applications to dynamics.
Introduction to programming in Matlab.
Introduction to analog and digital circuits.
Prerequisite: Phscs 250, 340; or instructor’s consent.
Recommended: knowledge of a computer programming
language.
Vacuum systems, machine shop practice, design and use of
digital and analog circuits, design of computer-controlled
experiments, Fourier analysis, writing proposals, technical
literature.
360. Statistical and Thermal Physics. (3:3:0) W Prerequisite: Phscs
222; Math 303 or 334.
Principles of statistical mechanics and thermodynamics, with
applications.
399R. Academic Internship. (1–9:Arr.:Arr. ea.) For students
engaged in the cooperative education program. F, W, Sp, Su
Prerequisite: both department chair’s and cooperative education
coordinator’s consent.
427, 428. Introduction to Astrophysics. (3:3:0 ea.) 427:F; 428:W
Prerequisite: Phscs 227, 228.
Principles and observational techniques of astrophysics.
430. Computational Physics Lab 3. (1:0:3) W, Su
Prerequisite: Phscs 222, 318, 330.
Static and dynamic boundary value problems, partial
differential equations. Applications in electrostatics,
thermodynamics, waves, and quantum mechanics. Programming
with Matlab.
441. Electrodynamics. (3:3:0) F, Sp Prerequisite: Phscs
220, 318. Recommended: concurrent enrollment in Phscs 430.
Classical theory of static electric and magnetic fields.
442. Electrodynamics. (3:3:0) W, Su Prerequisite: Phscs 441.
Maxwell’s equations, radiation, interaction of electromagnetic
fields with matter, and special relativity.
451. Quantum Mechanics. (3:3:0) F Prerequisite: Phscs 222, 318, or
equivalent.
Analytical foundations of quantum mechanics.
452. Applications of Quantum Mechanics. (3:3:0) W Prerequisite:
Phscs 451.
Applications of quantum mechanics to atomic, molecular,
statistical, condensed-matter, and nuclear physics; elementary
particles.
Recommended: Phscs 318.
Electromagnetic wave phenomena, including polarization
effects, interference, coherence, dispersion, ray theory, diffraction;
introduction to quantum nature of light. Laboratory component
emphasizes applications.
492R. Capstone Project in Applied Physics. (1–3:0:Arr. ea.) F, W,
Sp, Su
Senior capstone projects in applied physics. Topic must be
approved by department applied physics capstone project
coordinator or department chair.
Individually directed research for seniors. Thesis topic must be
cleared by faculty member before registration.
500-Level Graduate Courses (available to advanced
undergraduates)
513R. Special Topics in Contemporary Physics. (1–3:3:0 ea.) F, W
Prerequisite: instructor’s consent.
Topics generally related to recent developments in physics.
517, 518. Mathematical Physics. (3:3:0 ea.) 517:F; 518:W
Prerequisite: Phscs 318, Math 334.
Topics in modern theoretical physics, including applications of
matrix and tensor analysis and linear differential and integral
operators.
Prerequisite: Phscs 427, 428.
Advanced techniques of observational astronomy, emphasizing
knowledge and skills necessary to carry out observational
scientific investigation in astronomy.
545. Introduction to Plasma Physics. (3:3:0) F alt. yr. Prerequisite:
Phscs 321, 431, 441.
Introduction to plasma physics, including single-particle motion
and both fluid and kinetic models of plasma behavior.
561. Fundamentals of Acoustics. (3:3:0) F
Generation, transmission, and reception of sound. Vibrating
systems, properties of elastic media, mechanical and electrical
energy, and radiation.
562. Applied Acoustics. (3:3:0) W Prerequisite: Phscs 561 or
instructor’s consent.
Acoustic transducers, spectral analysis, waves in ducts and
enclosures, higher-order acoustic sources, fan noise, jet noise,
passive noise and vibration control, active noise and vibration
control.
565. Acoustics of Music and Speech. (3:3:0) W alt. yr. Prerequisite:
Phscs 561 or instructor’s consent.
Introduction to plasma physics, including single-particle motion
and both fluid and kinetic models of plasma behavior.
571. Laser Physics. (3:3:0) F alt. yr. Prerequisite: Phscs 471 or basic
understanding of electromagnetic waves and optics.
Laser amplification, cavity design, and control
Laser amplification, cavity design, and control
characterization of temporal and spatial modes. Applications in
nonlinear optics and atomic physics.
581. Solid-State Physics. (3:3:0) W Prerequisite: Phscs 222 or
equivalent.
Introduction for students in physics, chemistry, geology, and
engineering. Phenomena occurring in solids and their related
physical concepts.
583. Physics of Nanostructures, Surfaces, and Interfaces. (3:3:0) Prerequisite: Phscs 222 or equivalent. Recommended: Phscs 281 or 581 or equivalent; Phscs 451 or Chem 462 or equivalent. Properties of nanostructures, surfaces, and interfaces; experimental methods. Applications to emerging problems and opportunities in science and technology. Emphasis on concepts.

585. Thin-Film Physics. (3:3:0) W alt. yr. Prerequisite: Phscs 222 or equivalent. Preparation, characterization, use, and special properties of modern thin films; interdisciplinary treatment. Of interest to students in applied physics and engineering.

587. Physics of Semiconductor Devices. (3:3:0) F Prerequisite: Phscs 281 or 581 or ECEn 450. Device physics, with an in-depth study of the MOS transistor and other nanoscale computing devices.

591R. Colloquium. (0.5:1:0 ea.) F, W
Required of all graduate students every semester in residence.

597R. Introduction to Research. (0.5:0:1.5 ea.) F, W, Sp Su
One or two research areas to be selected, with 20 hours of participation required each semester.

Prerequisite: department cooperative education coordinator’s consent. Cooperative education internships off campus.

Graduate Courses
For 600- and 700-level courses, see the BYU 2003–2004 Graduate Catalog.

Physics and Astronomy Faculty
Professors

Associate Professors

Associate Research Professors

Assistant Professors

Assistant Research Professor

Emeriti