Physics

The physics curriculum at California Lutheran University addresses the question of how and why things work, from the forces which govern subatomic particles to the large-scale phenomena which shape our universe as a whole. The fundamental nature of physics accounts for its relevance not only in engineering and technology but also in the life and earth sciences. The various introductory courses offered by the Physics Department are thus tailored to meet the different needs of physics majors, students in other sciences and liberal arts students, in particular future teachers. The physics faculty members use a blend of interactive lectures, illustrative demonstrations and hands-on laboratory exercises to enhance students' comprehension of the material.

CLU offers both the bachelor of science and bachelor of arts in physics, as well as a physics minor. The B.S. program is well suited for students interested in graduate studies in physics or engineering or in careers in industry. The B.A. is a more liberal physics degree, where students can explore the relationship of physics with another field of interest.

Beginning physics students gain a strong background in classical physics, modern physics and applied mathematics. Upper division courses focus on both theoretical topics and experimental techniques. These small upper division classes, together with close supervision by the faculty, provide a uniquely personalized learning experience for the students.

Physics facilities include a teaching laboratory with networked workstations, an optics laboratory with a full-size optical bench and a variety of lasers, an atomic force microscope and a scanning electronic microscope. In addition a bioengineering laboratory contains experimental resources for biomaterials research. Physics also owns an eight-node linux cluster for use in parallel numerical simulations.

Physics students are encouraged to become actively involved in undergraduate research. CLU students have worked on projects in fluid dynamics, biomedical engineering, laser medicine, nuclear radiation and digital communication. Current research interests of the physics faculty include fluid dynamics, complex systems, bioengineering and electronics. Senior physics majors participate in original research work that culminates in a research paper. Physics majors often participate in summer undergraduate research programs as well as internships with local industries. Physics graduates easily find employment and those who opt to continue studies in graduate school are accepted into programs at universities throughout the nation.

Bachelor of Science in Physics

36 credits minimum, 27 credits upper division.

PHYS 211/211L	Mechanics and Thermodynamics-Calculus and Mechanics and Thermodynamics-Calculus Lab (recommended)	5
or PHYS 201/201L	Mechanics and Thermodynamics-Algebra	
PHYS 212/212L	Electricity, Magnetism, and Optics - Calculus and Electricity, Magnetism, and Optics - Calculus Lab	5
PHYS 303/303L	Radiation and Nuclear Physics and Modern Physcis Lab	4
At least four physics courses numbered 410 and above		16
At least one upper division physics course with a lab component beyond 303		4
PHYS 400	Senior Research Seminar	4
Total Hours		38

Only physics courses numbered 200 and above can count toward the physics credit requirements.

Required Supporting Courses

MATH 251	Calculus I	4
MATH 252	Calculus II	4
MATH 261	Calculus III	4
MATH 265	Differential Equations	4
Total Hours		16

Recommended

CHEM 151/151L	General Chemistry and General Chemistry Lab	5
CHEM 152/152L	General Chemistry II and General Chemistry II Lab	5
CSC 210	Introduction to Computer Programming	4
MATH 343	Linear Algebra	4

MATH 420	Real Analysis	4
MATH 450	Complex Analysis	4
Total Hours		26

Bachelor of Arts in Physics

40 credits minimum (28 credits physics, 12 credits concentration), 20 credits upper division physics.

PHYS 211/211L	Mechanics and Thermodynamics-Calculus and Mechanics and Thermodynamics-Calculus Lab (recommended)	5
or PHYS 201/201L	Mechanics and Thermodynamics-Algebra	
PHYS 212/212L	Electricity, Magnetism, and Optics - Calculus and Electricity, Magnetism, and Optics - Calculus Lab (recommended)	5
or PHYS 202/202L	Electricity, Magnetism, and Optics - Algebra	
PHYS 303/303L	Radiation and Nuclear Physics and Modern Physcis Lab	4
At least two physics courses numbered 410 and above		8
At least one upper division physics course with a lab component beyond 303		4
PHYS 400	Senior Research Seminar	4
12 Credit Concentration (at least 8 credits of upper division) *		12
Total Hours		42

*The concentration is a minimum of 12 credits in a single field outside of math or physics. It is expected that the presentation for the capstone will incorporate both physics and the field of concentration. Only physics courses numbered 200 and above can count toward the physics credit requirements.

Required Supporting Courses

MATH 251	Calculus I	4
MATH 252	Calculus II	4
MATH 261	Calculus III	4
MATH 265	Differential Equations	4
Total Hours		16

Recommended

CSC 210	Introduction to Computer Programming	4
MATH 343	Linear Algebra	4
MATH 420	Real Analysis	4
MATH 450	Complex Analysis	4
Total Hours		16

Minor in Physics

18 credits minimum, 10 credits upper division

PHYS 211/211L	Mechanics and Thermodynamics-Calculus and Mechanics and Thermodynamics-Calculus Lab (recommended)	5
or PHYS 201/201L	Mechanics and Thermodynamics-Algebra	
PHYS 212/212L	Electricity, Magnetism, and Optics - Calculus and Electricity, Magnetism, and Optics - Calculus Lab (recommended)	5
or PHYS 202/202L	Electricity, Magnetism, and Optics - Algebra	
10 Upper Division Physics Credits		10
Total Hours		20

Teaching Credential

Candidates for a California Secondary Teaching Credential should contact the School of Education Office for a complete list of course requirements for a Single Subject Waiver in Science.

Courses

Lower Division

PHYS 100. Introduction to Astronomy. (3).
An introduction to the solar and stellar objects in our visible universe.

PHYS 100L. Introduction to Astronomy Lab. (1).
Includes identification of constellations and planets, use of telescopes, analysis of astronomical data and field trips. Laboratory, 2 hours/week. Prerequisite or corequisite: PHYS 100.

PHYS 110. Physical Science for Liberal Art Majors. (4).
An introduction to physical science that includes fundamental forces in nature, conservation laws, energy transport, waves and the language of science. Emphasizes an explanation of everyday experiences and phenomena by asking questions about fundamental scientific concepts.

PHYS 110L. Physical Science for Liberal Arts Majors Lab. (0).

PHYS 201. Mechanics and Thermodynamics-Algebra. (4).
This algebra-based introductory course covers the mathematical description of motion, Newton's Laws, linear and circular motion, oscillatory motion and waves. Topics from thermodynamics include heat transfer, ideal gas laws, cyclic processes and entropy. Lecture, 3 hours/week; Laboratory, 2 hours/week. Prerequisite: MATH 151 or equivalent. (fall).

PHYS 201L. Mechanics and Thermodynamics-Algebra Lab. (0).

PHYS 202. Electricity, Magnetism, and Optics - Algebra. (4).
This algebra-based introductory course covers electrostatics, DC and AC electric currents, magnetism, Maxwell's equations, and geometric and physical optics. Lecture, 3 hours/week; Laboratory, 2 hours/week. Prerequisite: PHYS 201, PHYS 211 or permission of the instructor. (spring).

PHYS 202L. Electricity, Magnetism, and Optics - Algebra Lab. (0).

PHYS 209. Energy and Society. (4).
This introductory course is a discussion and empirical examination of the science of energy, its production, distribution, and consumption. Energy efficiency of automobiles and buildings. Energy production using fossil fuels, alternative energy, and renewable sources. Issues of economics, distribution and development. Students enrolled in the class MUST concurrently enroll in the corresponding laboratory course, PHYS 209L. Prerequisite: MATH 110 or equivalent.

PHYS 209L. Energy and Society Lab. (0).

PHYS 211. Mechanics and Thermodynamics-Calculus. (5).
This calculus-based introductory course covers the mathematical description of motion, Newton's Laws, linear and circular motion, oscillatory motion and waves. Topics from thermodynamics include heat transfer, ideal gas laws, cyclic processes and entropy. Lecture, 4 hours/week; Laboratory, 2 hours/week. Prerequisite or corequisite: MATH 251. (fall).

PHYS 211L. Mechanics and Thermodynamics-Calculus Lab. (0).

PHYS 212. Electricity, Magnetism, and Optics - Calculus. (5).
This calculus-based introductory course covers electrostatics, DC and AC electric currents, magnetism, Maxwell's equations and geometric and physical optics. Lecture, 4 hours/week; Laboratory, 2 hours/week. Prerequisites: PHYS 211 (recommended) or PHYS 201; prerequisite or corequisite: MATH 252. (spring).

PHYS 212L. Electricity, Magnetism, and Optics - Calculus Lab. (0).

PHYS 282. Selected Topics. (1-4).

PHYS 282L. Selected Topics Lab. (0).

Upper Division

PHYS 303. Radiation and Nuclear Physics. (4).
The study of foundations of quantum mechanics, atomic spectra, radioactive emissions, radiation health issues, nuclear reactions and elementary particle physics. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: MATH 252; PHYS 202 or PHYS 212. (fall, odd years).

PHYS 303L. Modern Physcis Lab. (0).

PHYS 309. Applied Electronics. (4).
Includes the study of DC and AC circuit analysis, network theorems, digital logic and logic network design, analog circuit design and digital computer interface. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: MATH 151; PHYS 202 or PHYS 212 or high school physics. (spring, odd years).

PHYS 309L. Applied Electronics Lab. (0).

PHYS 340. Advanced Physics Lab. (1-3).
A choice of selected experiments covering current topics in physics; open-ended to allow student initiative. Laboratory, 3 hours/week per credit. Prerequisite: PHYS 212.

PHYS 370. Digital Electronics. (3).
Includes logic, number systems, buss, memory and register design and in-depth architecture. Lecture, 2 hours/week; Laboratory, 3 hours/week. Prerequisite: MATH 151. (fall, even years).

PHYS 400. Senior Research Seminar. (4).
Independent study and research, interdisciplinary topic of current interest selected by the participants. Ongoing independent research results are presented for group discussions. Submittal of a research paper is required. Prerequisite: senior standing.

PHYS 405. Geophysics. (4).
An interdisciplinary study of how to use geophysical observations of the Earth's gravitational and magnetic fields, seismic wave velocities and subsurface electrical resistivity to solve geological and environmental problems. Specific field methods using geophysical instruments will be taught along with the interpretation of the collected data. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: PHYS 201 & PHYS 202 or PHYS 211 & PHYS 212. GEOL 111 or GEOL 152 recommended. (cross-listed with GEOL 405).

PHYS 405L. Geophysics Lab. (0).

PHYS 410. Dynamics and Chaos. (3).
Includes the study of single-particle dynamics, reference systems, oscillations, Lagrangian and Hamiltonian mechanics. Nonlinear systems, phase plots, the surface of section, toroidal motion, chaos and the KAM theorem are the focus of the latter part of the class. Prerequisites: MATH 261, MATH 265; PHYS 212. (fall, even years).

PHYS 415. Thermodynamics and Kinetic Theory. (3).
Introduces the fundamental concepts and laws of thermodynamics and kinetic theory of gases. Prerequisites: MATH 261, MATH 265; PHYS 212. (fall, even years).

PHYS 420. Electrodynamics. (4).
Solution techniques of Maxwell's equations are developed for static and time dependent electric and magnetic fields. Specific topics include: The electrical potential and Laplace's equation, boundary value problems, multipole expansions, electric and magnetic fields in matter, electrodynamics, and the propagation of electromagnetic fields through media. Also includes introduction to special relativity and relativistic electrodynamics. Prerequisites: MATH 261 and MATH 265, PHYS 212 and PHYS 440.

PHYS 425. Geometric and Physical Optics. (3).
The study of electro-magnetic waves, reflection and refraction, interference, diffraction, Fourier optics, fiber optics and nonlinear effects. Prerequisites: MATH 261, MATH 265; PHYS 212. (fall, odd years).

PHYS 430. Quantum Physics. (4).
An introduction to quantum theory, beginning with the Schrödinger equation and the statistical interpretation of the wave function. One-dimensional applications, include the harmonic oscillator, square-well potentials and tunneling. Three dimensional applications include, the theory of angular momentum, spin, the hydrogen atom, identical particles, time-independent perturbation theory and the Pauli exclusion principle. Other approximate solution techniques with applications to atoms, molecules, and solids are presented. Prerequisites: MATH 261 and MATH 265, PHYS 212 and PHYS 440.

PHYS 440. Mathematical Methods of Physics. (4).
Mathematics with a focus to meet the needs of students with a major or minor in physics or engineering disciplines. Topics include: complex variables, linear algebra, coordinate transformations, vector analysis, Fourier series and transforms; Laplace transforms, the Dirac delta function, Green functions, calculus of variations and solution techniques for partial differential equations with specific applications to Laplace's equation. Prerequisites: MATH 261 and PHYS 212. Recommended: MATH 265. (Cross-listed with MATH 440).

PHYS 482. Selected Topics. (1-4).

PHYS 482L. Sel Topics: Lab. (1-4).

PHYS 490. Independent Study. (1-4).

PHYS 492. Internship. (2-4).

PHYS 497. Departmental Honors. (4).
This course allows academically motivated students the opportunity to explore a research topic of their choosing at a level of depth beyond the one-semester Capstone course. Students will complete two semesters of Physics 497 to satisfy the requirements of the Physics department Honors program. Upon completion of the two semesters, the student will present in a public forum, such as the CLU Festival of Scholars, or equivalent.