# PHYSICS

## Faculty

Michael Crosser, Ph.D. (Chair)
Joelle Murray, Ph.D.
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## Laboratory Coordinator

Luis Barajas Lopez

Physics explores the underlying rules that describe the behavior of the universe in all its complexity, including objects ranging in size from smaller than an atom to larger than a galaxy. By increasing our understanding of the physical world around us, physics has been the driving force for many advances in technology including electronics, medical imaging techniques, microscopy, and communications.

The Department of Physics maintains a history of successfully training students through two majors: physics and applied physics. The curriculum for both majors is organized to provide a strong, research oriented background. Because of its fundamental nature, physics is closely intertwined with other sciences and engineering, and physics students pursue a wide variety of directions after graduation.

The physics major trains students more generally in physics, and graduates often continue to graduate programs in physics, medical physics, applied math, or electrical engineering; to teaching; or to medical school. The applied physics major is for students who wish to continue in more applied fields, usually mechanical or civil engineering, materials science, or employment in technology related industry.

## Organizations and Honors

### Sigma Pi Sigma

The National Physics Honor Society was founded at Davidson College in North Carolina in 1921, and became a national society in 1925. About 2,000 members are inducted annually into over 460 chapters. The Linfield University chapter was installed on April 17, 1959, with 29 charter members. New members are elected by the chapter each year from among those students who

1. have completed at least three semesters of college work,
2. rank in the upper third of their college class in overall scholarship,
3. have completed at least three full semester courses in physics and
4. have earned a minimum grade point average of 3.000 overall and 3.200 in physics courses.

### The Senior Science Prize

The Senior Science Prize was established to encourage students in the natural sciences and mathematics to plan for graduate study and eventual careers in the field of pure and applied science and mathematics. The prize will be awarded to students scoring on the Graduate Record Examination at the 90th percentile in chemistry, mathematics, or physics; in the 95th percentile in biology, computer science, or engineering.

## Programs

- Physics Major (http://catalog.linfield.edu/programs-az/arts-sciences/physics/physics-major/)
- Physics Major with Material Science Focus (http://catalog.linfield.edu/programs-az/arts-sciences/physics/physics-major-material-science-focus/)
- Applied Physics Major (http://catalog.linfield.edu/programs-az/arts-sciences/physics/applied-physics-major/)
- Applied Physics Major with Engineering Focus (http://catalog.linfield.edu/programs-az/arts-sciences/physics/applied-physics-major-engineering-focus/)
- Physics Minor (http://catalog.linfield.edu/programs-az/arts-sciences/physics/physics-minor/)

## Courses

### Paracurricular Courses

**ENGR 025 LABORATORY TECHNIQUES: MACHINE SHOP (1 credit)**
$30 lab fee. 1 credit. (EL)
*Total Course fees:* $30.00
*(EXPERIENTIAL LEARNING)*

### Physics Courses

**PHYS 100 HOW THINGS WORK (3 credits)**
Introduction to physical concepts behind modern technology. Studies of science of every day phenomena considered, including how electricity is generated, how refrigerators operate, and how CDs and DVDs contain information. Lecture, readings, writing, and discussion.
*Prerequisites:* MATH 105 or equivalent recommended.
*(NATURAL WORLD)*

**PHYS 101 DESCRIPTIVE ASTRONOMY (3 credits)**
The solar system, stars and their evolution, galaxies and cosmology. Emphasis on observational evidence. Lecture, discussion, and occasional evening observing sessions.
*(NATURAL WORLD)*

**PHYS 102 THE PHYSICS OF ART & MUSIC (3 credits)**
Ways that artistic expression are explained through physical mechanisms. Studies of light, color, and sound will be explored. Lecture, discussion, and occasional evening trips.
*Total Course fees:* $50.00
*(NATURAL WORLD)*

**PHYS 207 ENERGY AND SUSTAINABILITY (ALSO LISTED AS ENVS 207) (3 credits)**
Introduction to the scientific principles of energy technologies with a focus on assessing sustainability including environmental, climate, and life-cycle analysis. A wide range of renewable and nonrenewable energy sources will be studied, along with our use of energy for applications including electricity, transportation, heat, materials, and food production. Quantitative methods for making comparisons will be emphasized. The outlook for various renewable energy technologies will be discussed. Offered as stacked course with PHYS/ENVS 307. May not take both PHYS/ENVS 207 and PHYS/ENVS 307 for credit.
*Typically offered:* Fall Semester, Even Years
*(QUANTITATIVE REASONING)*

**PHYS 210 INTRODUCTION TO MECHANICS (5 credits)**
Introduction to the various ways in which the mechanical universe is described, using the concept of particles, waves, and flows. Extensive treatment of Newtonian mechanics, including motion, forces, energy, and waves. The special theory of relativity and basic ideas of quantum mechanics are introduced. Lecture, discussion, and laboratory.
*Total Course fees:* $15.00
*Prerequisites:* MATH 170 (may be taken concurrently).
*(QUANTITATIVE REASONING)*

**PHYS 211 INTRODUCTION TO ELECTROMAGNETISM (5 credits)**
Introduction to the study of electromagnetic force, including the basic laws of electricity and magnetism, the concept of a field, Maxwell's equations, basic circuits, electromagnetic radiation, and optics. The relationship of electromagnetism to the special theory of relativity. Lecture, discussion, and laboratory.
*Total Course fees:* $15.00
*Prerequisites:* PHYS 210 and MATH 170. MATH 175 recommended to be taken concurrently.
*(QUANTITATIVE REASONING)*

**PHYS 215 MODERN PHYSICS (4 credits)**
Developments since 1900; relativity, the nature of radiation and matter and their interaction, radioactivity, elementary quantum mechanics, introductory atomic and nuclear physics. Lecture and discussion.
*Prerequisites:* PHYS 211 and MATH 175. PHYS 385 and CHEM 210 recommended to be taken concurrently.
*Typically offered:* Fall Semester
*(NATURAL WORLD)*

**PHYS 220 THERMAL & STATISTICAL PHYSICS (3 credits)**
Study of solids, liquids, and gases at the atomic level to develop appreciation for and mathematical understanding of their thermal properties. Topics derive from thermodynamics, statistical mechanics, and solid state physics including transport processes, energy distributions, classical and quantum statistical development. CHEM 210 recommended.
*Prerequisites:* PHYS 211 and MATH 175. CHEM 210 recommended.
*Typically offered:* Spring Semester

**PHYS 298 SPECIAL TOPICS: JAN TERM TRAVEL (4 credits)**
See specific sections for descriptions.
*Prerequisites:* IDST 098 previous fall.

**PHYS 303 INTRODUCTION TO MATERIALS SCIENCE (ALSO LISTED AS ENGR 303) (3 credits)**
Introduction to the science of materials (metals, ceramics, polymers, composites, and semiconductors). Crystal structures and designations. Techniques of materials characterization. Mechanical, thermal, electrical, and magnetic properties. Forming and materials processing. Problem solving, lecture, discussion, and field trips.
*Prerequisites:* PHYS 215.

**PHYS 307 ENERGY & SUSTAINABILITY (ALSO LISTED AS ENVS 307) (4 credits)**
Introduction to the scientific principles of energy technologies with a focus on assessing sustainability including environmental, climate, and life-cycle analysis. A wide range of renewable and nonrenewable energy sources will be studied, along with our use of energy for applications including electricity, transportation, heat, materials, and food production. Quantitative methods for making comparisons will be emphasized. The outlook for various renewable energy technologies will be discussed. This course will include higher level scientific modeling and analysis than ENVS 207 and is recommended for science and mathematics majors. May not take both PHYS/ENVS 207 and PHYS/ENVS 307 for credit.
*Prerequisites:* One of MATH 175, PHYS 210, CHEM 210, ENVS 201, or consent of instructor; a year-long laboratory science course is recommended.
*Typically offered:* Fall Semester, Even Years
*(QUANTITATIVE REASONING)*

**PHYS 315 CIRCUITS AND ELECTRONICS I (ALSO LISTED AS ENGR 315) (4 credits)**
Electrical concepts and measurements. Circuit laws and theorems. Analysis of dc and ac steady state circuits, including phasor analysis techniques and Bode plots. Operational amplifiers and diodes. Digital combinational and sequential logic circuitry. Lecture, discussion, and laboratory.
*Prerequisites:* MATH 170. PHYS 211, junior standing recommended.
*Typically offered:* Fall Semester, Even Years
*(NATURAL WORLD)*

**PHYS 316 CIRCUITS AND ELECTRONICS II (ALSO LISTED AS ENGR 316) (4 credits)**
Semiconductor materials and solid-state devices. Diode and transistor circuits. Selected topics such as magnetism, inductors, and transformers; second-order ac and dc circuit analysis; Laplace and Fourier transforms; analog to digital conversion; and electronic system design. Completion of an independent project. Lecture, discussion, and laboratory.
*Prerequisites:* PHYS 315.
*Typically offered:* Spring Semester, Odd Years
*(QUANTITATIVE REASONING)*

**PHYS 325 COMPUTATIONAL PHYSICS (4 credits)**
Use of various numerical methods (solving ODE's, numerical integration, statistical analysis, Monte-Carlo simulation) coded in Python. Detail explorations in scientific writing style using LaTeX. Laboratory and lecture.
*Prerequisites:* MATH 170 and PHYS 211 or consent of instructor.
*(QUANTITATIVE REASONING)*

**PHYS 370 ADVANCED TOPICS IN PHYSICS (3 credits)**
Selected advanced physics topics.
*Prerequisites:* PHYS 215 or consent of instructor.

**PHYS 385 GREAT EXPERIMENTS IN PHYSICS (1 credit)**
Experiments in modern physics, thermal physics, and electricity and magnetism. Introduction to planning and executing physics experiments. Introduction to writing reports in the standard journal style.
*Prerequisites:* PHYS 215 (may be taken concurrently).

**PHYS 386 EXPLORATION IN EXPERIMENTAL PHYSICS (1 credit)**
Design and execution of physics experiments. Most projects will be drawn from topics in modern physics, thermal physics, and electricity and magnetism. Results will be reported using standard journal style.
*Prerequisites:* PHYS 385.
*Typically offered:* Spring Semester

**PHYS 398 SPECIAL TOPICS: JAN TERM TRAVEL (4 credits)**
See individual sections in specific terms for descriptions. 4 credits.
*Prerequisites:* IDST 098 previous fall.
*(GLOBAL PLURALISM, NATURAL WORLD)*

**PHYS 420 CLASSICAL MECHANICS (4 credits)**
Classical theories and analytical methods of statics and dynamics: kinematics, vectors and tensors, potential theory, moving coordinate systems and generalized methods. Lecture and discussion. MATH 210 recommended.
*Prerequisites:* PHYS 211 and MATH 200. MATH 210 recommended.
*Typically offered:* Fall Semester

**PHYS 440 ELECTRICITY AND MAGNETISM I (3 credits)**
Review of vector analysis, electrostatic and magnetostatic theory, field properties in matter. Lecture and discussion. MATH 210 recommended.
*Prerequisites:* PHYS 211 and MATH 200. MATH 210 recommended.
*Typically offered:* Fall Semester

**PHYS 441 ELECTRICITY & MAGNETISM II (3 credits)**
Electrodynamics, Maxwell's equations, electromagnetic waves, radiation, relativity.
*Prerequisites:* PHYS 440.
*Typically offered:* Spring Semester

**PHYS 475 QUANTUM PHYSICS (4 credits)**
Quantum mechanics and its application in studies of atomic systems and nuclei. Lecture and discussion. PHYS 420, MATH 210, MATH 250 and junior standing recommended.
*Prerequisites:* PHYS 215 and MATH 200. PHYS 420, MATH 210, MATH 250 and junior standing recommended.
*Typically offered:* Spring Semester

**PHYS 480 INDEPENDENT STUDY (1-5 credits)**
Supplemental work for students with advanced standing in physics. By permission.

**PHYS 485 PHYSICS COLLOQUIUM (1 credit)**
Presentations of topics of current interest by visiting speakers, faculty, and students. May be repeated for credit.

**PHYS 488 RESEARCH (1-5 credits)**
Individual research projects for Physics and Applied Physics majors. Work done in collaboration with faculty. Departmental permission required. May be repeated for credit.
*Prerequisites:* Departmental permission required.

**PHYS 489 THESIS RESEARCH (1-5 credits)**
Required of all Physics and Applied Physics majors in the senior year.
*Prerequisites:* PHYS 386.

**PHYS 490 SENIOR THESIS (3 credits)**
Comprehensive written report on advanced level individual investigative project. Also requires public oral presentation of project and participation in Physics Colloquium. Baccalaureate thesis required of all Physics and Applied Physics majors.
*Prerequisites:* PHYS 489 or ENGR 489 and senior standing.
*Typically offered:* Spring Semester
*(MAJOR WRITING INTENSIVE)*

## Engineering Courses

**ENGR 252 ENGINEERING STATICS AND DYNAMICS (4 credits)**
Newtonian mechanics with emphasis on problem-solving and engineering applications: force, mass, and acceleration; force systems; free-body diagrams; distributed forces; particle kinematics; motion of rigid bodies; conservation of energy; translational and angular momentum; systems of particles; applications of vector algebra and calculus. Lecture and discussion.
*Prerequisites:* PHYS 210. MATH 200 (must be taken prior or concurrently).
*Typically offered:* Fall Semester, Odd Years

**ENGR 253 STRENGTH OF MATERIALS (3 credits)**
Continuation of study of engineering mechanics following 252. Equilibrium and geometric compatibility in devices and structures; Hooke's Law, stress and strain in variously loaded members; deformation and deflection; theory of failure. Lecture and discussion.
*Prerequisites:* PHYS 210 and ENGR 252.
*Typically offered:* Spring Semester, Even Years

**ENGR 303 INTRODUCTION TO MATERIALS SCIENCE (ALSO LISTED AS PHYS 303) (3 credits)**
Introduction to the science of materials (metals, ceramics, polymers, composites, and semiconductors). Crystal structures and designations. Techniques of materials characterization. Mechanical, thermal, electrical, and magnetic properties. Forming and materials processing. Problem solving, lecture, discussion, and field trips.
*Prerequisites:* PHYS 215.

**ENGR 310 ENGINEERING DESIGN & GRAPHICS (3 credits)**
Engineering drawing standards, projection theory, visual thinking, free-hand sketching, pictorial sketching, solid modeling (including operating 3-D printer), and tolerance concepts. Introduction to drafting using computeraided design programs and other tools. Lecture and laboratory.
*Total Course fees:* $50.00
*Prerequisites:* ENGR 025, PHYS 210, and MATH 170 must be completed prior.
*Typically offered:* Spring Semester, Odd Years

**ENGR 315 CIRCUITS AND ELECTRONICS I (ALSO LISTED AS PHYS 315) (4 credits)**
Electrical concepts and measurements. Circuit laws and theorems. Analysis of dc and ac steady state circuits, including phasor analysis techniques and Bode plots. Operational amplifiers and diodes. Digital combinational and sequential logic circuitry. Lecture, discussion, and laboratory.
*Prerequisites:* MATH 170. PHYS 211, junior standing recommended.
*Typically offered:* Fall Semester
*(NATURAL WORLD)*

**ENGR 316 CIRCUITS AND ELECTRONICS II (ALSO LISTED AS PHYS 316) (4 credits)**
Semiconductor materials and solid-state devices. Diode and transistor circuits. Selected topics such as magnetism, inductors, and transformers; second-order ac and dc circuit analysis; Laplace and Fourier transforms; analog to digital conversion; and electronic system design. Completion of an independent project. Lecture, discussion, and laboratory.
*Prerequisites:* PHYS 315 or ENGR 315.
*Typically offered:* Spring Semester, Odd Years
*(QUANTITATIVE REASONING)*

**ENGR 489 ENGINEERING DESIGN PROJECT (4 credits)**
Design an engineering solution to a specified need, incorporating appropriate engineering process and standards and meeting multiple realistic constraints. Research prior knowledge; identify clear design specifications; create prototypes; conduct appropriate experimentation, modeling, and theoretical analysis; and analyze and interpret results. Each student's individual contribution will address a unique project component or system and be appropriate and sufficient for writing up as a senior thesis. Recommended: an 8-9 credit sequence to develop practical engineering and science skills, such as: ENGR 025, ENGR 252, ENGR 253; or ENGR 315, ENGR 316; or COMP 160, COMP 161, COMP 262.
*Prerequisites:* ENGR 310 and consent of instructor. Recommended: an 8-9 credit sequence to develop practical engineering and science skills, such as: ENGR 025, ENGR 252, ENGR 253; or ENGR 315, ENGR 316; or COMP 160, COMP 161, COMP 262.
*Typically offered:* Fall Semester