PHYSICS

A major in physics provides a solid basis for almost any scientific, engineering, or technically oriented career. Students study the fundamental laws of nature and develop an understanding of how they can be applied towards solving our most challenging problems. Therefore, the Department of Physics and Engineering (https://www.bethel.edu/undergrad/academics/physics/) seeks to prepare students in a liberal arts setting for careers in physics, engineering, and related fields. Many students with a physics or applied physics major begin working in industry as engineers, but a major in physics or applied physics is also excellent preparation for graduate studies in physics or engineering and leads to careers in research and development, academia, or national and government labs. The department is also committed to making physics a significant component of the liberal arts experience for other Bethel students. A physics minor is available to students majoring in any other field.

Advanced Placement: The Physics and Engineering Department requires a score of 4 or better on an AP exam in order for the exam to be used to fulfill course requirements in the majors it offers. Students with a score of 3 will receive elective credit or credit toward General Education requirements. Students should consult the department chair with questions about AP exams and requirements for majors.

Majors in Physics

- B.A. in Physics (https://catalog.bethel.edu/arts-sciences/academic-programs-departments/physics/physics-ba/)
- B.S. in Applied Physics (https://catalog.bethel.edu/arts-sciences/academic-programs-departments/physics/applied-physics-bs/)
- B.S. in Physics (https://catalog.bethel.edu/arts-sciences/academic-programs-departments/physics/physics-bs/)

Minor in Physics

- Physics (https://catalog.bethel.edu/arts-sciences/academic-programs-departments/physics/physics-minor/)

PHY 102 • Physics of Everyday Life 3 Credits
Explores how physics concepts can be used to understand everyday phenomena in the world around us. Topics include: mechanics, waves (including sound and light), thermodynamics, and atomic and nuclear physics. Lecture demonstrations and laboratories stress a clear understanding of observed phenomena.
Corequisites: Concurrent registration in PHY 102D is required. Offered: January.

PHY 102D • Physics of Everyday Life-Lab 1 Credit
Laboratory experience accompanying PHY 102.
Corequisites: Concurrent registration in PHY 102 is required. Offered: January.

PHY 112 • Introduction to Astronomy 3 Credits
The concepts, techniques, and tools of astronomy and astrophysics for nonscience students. Includes historical overview; identification of constellations; telescopes; the nature of light, atomic spectra, and structure; the nuclear physics of stars; the life cycle of stars; and current theories of the fate of the universe.
Corequisites: Concurrent registration in PHY 112D is required. Offered: Fall.

PHY 112D • Introduction to Astronomy Lab 1 Credit
Laboratory experience accompanying PHY 112. Includes optics, atomic spectra, and observations with simple instruments and telescopes.
Corequisites: Concurrent registration in PHY 112 is required. Offered: Fall.

PHY 202 • Introductory Physics I 3 Credits
Mechanics, thermal properties of matter and mechanical waves.
Prerequisites: MAT 121M, MAT 124M, or solid understanding and competency in high school mathematics as demonstrated by at least one of the following: a Math ACT score of at least 23, 519 on the Math portion of the SAT, a Math Placement Test score of at least 2. Corequisites: Concurrent registration in PHY 202D is required. Offered: Fall.

PHY 202D • Introductory Physics I Lab 1 Credit
Laboratory experience accompanying PHY 202.
Corequisites: Concurrent registration in PHY 202 is required. Offered: Fall.

PHY 206 • Introductory Physics II 3 Credits
Electricity and magnetism, sound waves, optical phenomena, and modern physics.
Prerequisites: PHY 202/PHY 202D. Corequisites: Concurrent registration in PHY 207 is required. Offered: Spring.

PHY 207 • Introductory Physics II Lab 1 Credit
Laboratory experience accompanying PHY 206.
Corequisites: Concurrent registration in PHY 206 is required. Offered: Spring.

PHY 260 • Careers in Engineering and Physics Seminar 1 Credit
Developing careers in high-technology fields such as engineering and physics. Explores the wide variety of specific careers possible through video, lecture, tours, and guest speakers. Develops practical professional skills such as writing resumes and cover letters, accumulating connections and experience, and techniques for interviewing.
Prerequisites: PHY 296/PHY 297. Offered: Fall. Special Notes: This course carries cross-credit in engineering.

PHY 292 • General Physics I 3 Credits
Kinematics, mechanics, oscillations, fluids, and conservation principles.
Prerequisites: MAT 124M or Consent of instructor. Corequisites: Concurrent registration in PHY 292D is required. Offered: Fall, Spring.

PHY 292D • General Physics I Lab 1 Credit
Laboratory experience accompanying PHY 292.
Corequisites: Concurrent registration in PHY 292 is required. Offered: Fall, Spring.

PHY 296 • General Physics II 3 Credits
Electricity, magnetism, thermodynamics, sound waves, and optics.
Prerequisites: PHY 292/PHY 292D (with a grade of a C or higher); MAT 125 or Consent of instructor. Corequisites: Concurrent registration in PHY 297 is required. Offered: Fall, Spring.

PHY 297 • General Physics II Lab 1 Credit
Laboratory experience accompanying PHY 296.
Corequisites: Concurrent registration in PHY 296 is required. Offered: Fall, Spring.

PHY 302 • Electronics 3 Credits
Fundamentals of digital and analog electronics intended for scientists and engineers.
Prerequisites: MAT 125 or Consent of instructor. Corequisites: Concurrent registration in PHY 303 is required. Offered: Fall. Special Notes: PHY 296/PHY 297 is a strongly recommended prerequisite.

PHY 303 • Electronics Lab 1 Credit
Laboratory experience accompanying PHY 302. Extensive laboratory exercises and a choice of projects provide hands-on experience with circuits using transistors, operational amplifiers, logic gates, flip-flops, and other devices.
Corequisites: Concurrent registration in PHY 302 is required. Offered: Fall.

PHY 312 • Modern Physics 3 Credits
Relativity, quantum theory, introductory wave mechanics, nuclear processes, elementary particles, and cosmology.
Prerequisites: PHY 296/PHY 297 with a C grade or higher and MAT 223. Corequisites: Concurrent registration in PHY 313 is required. Offered: Spring.

PHY 313 • Modern Physics Lab 1 Credit
Laboratory experience accompanying PHY 312.
Corequisites: Concurrent registration in PHY 312 is required. Offered: Spring.

PHY 322 • Mathematical Methods in Physics and Engineering 2 Credits
Development of skill in mathematical techniques useful in the solution of physics and engineering problems. Included are Fourier analysis; complex numbers; partial differential equations and their solutions.
Prerequisites: [MAT 222 or MAT 224 (may be taken concurrently)] and MAT 223. Offered: Fall. Special Notes: This course carries cross-credit with engineering. ENR 321 is a strongly encouraged prerequisite.

PHY 332 • Optics 3 Credits
Principles of geometrical and physical optics.
Prerequisites: PHY 312/PHY 313 and MAT 223. Corequisites: Concurrent registration in PHY 333 is required. Offered: Spring, even # years.

PHY 333 • Optics Lab 1 Credit
Laboratory experience accompanying PHY 332 emphasizing physical optics measurements, laser technology, and holography.
Corequisites: Concurrent registration in PHY 332 is required. Offered: Spring, even # years.

PHY 336 • Signals and Systems 4 Credits
Continuous and discrete-time signals and systems. Topics include: definitions and properties of signals and systems, convolution, solution of differential and difference equations. Laplace and Z transforms, and Fourier analysis. Emphasis on applications to signal processing, communication, and control systems.
Prerequisites: MAT 222 or MAT 224; PHY 302/PHY 303; ENR 352/PHY 352 ENR 353/PHY 353. Offered: Fall, even # years. Special Notes: This course carries cross-credit with engineering.

PHY 340 • Mechanics 4 Credits
Particle and rigid body dynamics, conservative and nonconservative forces, central forces, accelerated coordinate systems, and Lagrange's equations of motion.
Prerequisites: PHY 296/PHY 297 with a C grade or higher; MAT 223. Offered: Fall. Special Notes: This course carries cross credit in engineering.

PHY 352 • Computer Methods in Physics and Engineering 3 Credits
Application of the computer to solving applied problems of interest to physicists and engineers. Computer techniques are developed for numerical methods, simulation models, and data acquisition and control in the laboratory.
Prerequisites: COS 101 or COS 111 and MAT 223 or MAT 224 and PHY 296/PHY 297 with a C grade or higher or Consent of instructor. Corequisites: Concurrent registration in PHY 353 is required. Offered: Spring. Special Notes: This course carries cross-credit in engineering and PHY 302/PHY 303 is a recommended prerequisite.

PHY 353 • Computer Methods in Physics and Engineering Lab 1 Credit
Laboratory experience accompanying PHY 352.
Corequisites: Concurrent registration in PHY 352 is required. Offered: Spring. Special Notes: This course carries cross-credit in engineering.

PHY 365 • Physics Research Seminar 1 Credit
An introduction to research in physics and the development of scientific writing skills. Emphasis on preparing for departmental research experiences such as PHY 490 and external research experiences such as those found in industry, summer fellowship programs, and graduate schools.
Prerequisites: PHY 260; PHY 312/PHY 313; Junior standing; A major in the Physics and Engineering department. Offered: Spring.

PHY 400 • Electricity and Magnetism 4 Credits
Electrostatics and magnetostatics, electric and magnetic fields in free space and in materials, electromagnetic waves, and transmission lines.
Prerequisites: PHY 296/PHY 297 with a C grade or higher; MAT 222 or MAT 224; MAT 223. Offered: Fall, odd # years.

PHY 410 • Thermodynamics 4 Credits
Laws of thermodynamics, conditions for thermodynamic equilibrium, and fundamentals of statistical mechanics.
Prerequisites: PHY 296/PHY 297 with a C grade or higher and MAT 223. Offered: Spring, odd # years. Special Notes: PHY 312/PHY 313 is a strongly recommended prerequisite.

PHY 422 • Fluid Mechanics 3 Credits
Laws of statics, kinematics, and dynamics applied to fluid mechanics. Integral and differential conservation laws for mass, momentum, and energy. Dimensional analysis, viscous pipe flow, boundary layers, separated flows, and potential flow.
Prerequisites: MAT 223 and PHY 296/PHY 297 with a C grade or higher. Corequisites: Concurrent registration in PHY 423 is required. Offered: Fall. Special Notes: This course carries cross-credit in engineering.

PHY 423 • Fluid Mechanics Lab 1 Credit
Laboratory experience accompanying PHY 422.
Corequisites: Concurrent registration in PHY 422 is required. Offered: Fall. Special Notes: This course carries cross-credit in engineering.

PHY 424 • Electronic Materials and Devices 3 Credits
Theory and application of condensed matter and materials. Physical origin of electrical, optical, mechanical, thermal, and magnetic properties. Emphasis on devices such as pn junction diodes, LEDs, piezoelectrics, and sensors.
Prerequisites: PHY 302/PHY 303 or PHY 312/PHY 313. Corequisites: Concurrent registration in PHY 425 is required. Offered: Fall, even # years. Special Notes: This course carries cross-credit in engineering.

PHY 425 • Electronic Materials and Devices Laboratory 1 Credit
Laboratory component of PHY 424. Explores characterization of materials and the design, fabrication, and testing of devices.
Corequisites: Concurrent registration in PHY 424 is required. Offered: Fall, even # years. Special Notes: This course carries cross-credit in engineering.

PHY 432 • Laser Fundamentals 3 Credits
Properties and types of lasers; lasing dynamics; modern applications.
Prerequisites: PHY 312/PHY 313 and MAT 223. Corequisites: Concurrent registration in PHY 433 is required. Offered: Spring, odd # years.

PHY 433 • Laser Fundamentals Lab 1 Credit
Laboratory experience accompanying PHY 432.
Corequisites: Concurrent registration in PHY 432 is required. Offered: Spring, odd # years.

PHY 440 • Quantum Mechanics 4 Credits
The concepts and techniques of quantum mechanics.
Prerequisites: PHY 312/PHY 313; MAT 222 or MAT 224; MAT 223. Offered: Fall, even # years.

PHY 450 • Topics in Physics and Engineering 3-4 Credits
Topics selected from various fields of engineering and physics for the purpose of illustrating the practical application of physical principles. Emphasis on developing the skills and viewpoints commonly used by engineers and physicists. The field of engineering or physics is announced prior to registration.
Prerequisites: Consent of instructor. Offered: Occasionally. Special Notes: This course may be repeated when a different topic is emphasized. This course carries cross-credit in engineering.

PHY 481 • Internship in Physics 1-4 Credits
A practical experience in an off-campus professional setting in which skills and perspectives of a physicist are applied. Experience is designed by student in consultation with a faculty member.
Prerequisites: Major in applied physics or physics and Junior or senior standing. Offered: Fall, Spring, Summer.

PHY 490 • Research 3 Credits
An opportunity for individual student projects under the supervision of the faculty.
Prerequisites: Senior standing; PHY 365; Major in Physics and Engineering department. Offered: Fall, Spring.