

PHYSICS

Department of Physics and Astronomy

Website: <https://www.washburn.edu/academics/college-schools/arts-sciences/departments/physics-astronomy/index.html> (<https://www.washburn.edu/academics/college-schools/arts-sciences/departments/physics-astronomy/>)

Faculty

Professor Karen Camarda, PhD, Chair
 Professor Brian Thomas, PhD
 Senior Lecturer Keith Mazachek, PhD

Mission

The mission of the Physics and Astronomy Department is to engage our community in an impassioned and continued search for intellectual growth in the fields of physics, astronomy, engineering, and geology. The department will accomplish this mission by: offering general education courses to all students; providing a comprehensive and personalized foundation for majors, which will prepare them for a career in their chosen field; performing research and scholarship which broadens the horizons of knowledge and informs our teaching, and; providing public access to the planetarium and observatory and conducting educational programs in physics, astronomy, engineering, and geology for the intellectual enrichment of the citizens of the state of Kansas.

Student Learning Outcomes

Physics students at Washburn University, upon graduation, are expected to have:

- Acquired an understanding of the vocabulary and methodology of physics.
- Demonstrated the ability to move from observations to logical conclusions, and apply analytical thinking.
- Acquired knowledge of the subject matter in terms of content, problem solving, experimental design, data reduction and analysis.

Natural Science Concentration

All Bachelor of Science degrees include a required 30-hour natural science concentration, which includes courses chosen from departments in the Natural Sciences and Mathematics Division, other than the student's major department. At least 15 of these hours must be in one department. The 30 hours must be approved by the student's major department chairperson.

Departmental Honors

Students are eligible to receive departmental honors upon graduation if they fulfill the following minimum requirements:

- A grade point average of 3.5 in the major, including a 3.5 in upper-division work in the major.
- Successful completion of PS 360 Physics Research or PS 368 Computational Physics Research.
- Service to the Department, or to the community relevant to the major.
- The recommendation of the Department.

Programs

- Physics, BS (<https://catalog.washburn.edu/undergraduate/college-arts-sciences/physics/physics-bs/>)
- Physics, BA (<https://catalog.washburn.edu/undergraduate/college-arts-sciences/physics/physics-ba/>)
- Computational Physics, BS (<https://catalog.washburn.edu/undergraduate/college-arts-sciences/physics/computational-physics-bs/>)
- Engineering Physics, AS (<https://catalog.washburn.edu/undergraduate/college-arts-sciences/physics/engineering-physics/>)
- Physics, Minor (<https://catalog.washburn.edu/undergraduate/college-arts-sciences/physics/physics-minor/>)

Course Offerings

AS 101 Introduction to Astronomy/Cosmology (3)

A qualitative study of stellar, galactic, and extragalactic astronomy and cosmology surveying what is known and how it is known.

Course Attributes:

- Gen Ed AY 2024-2025: Scientific Reasoning and Literacy
- Gen Ed Pre-AY 2024-2025: Natural Science
- USLO: Quantitative and Scientific Reasoning and Literacy

AS 102 Introduction to Astronomy - Solar System (3)

A qualitative study of the history of astronomy, the origin, evolution, and functioning of the solar system surveying what is known and how it is known.

Course Attributes:

- Gen Ed AY 2024-2025: Scientific Reasoning and Literacy
- Gen Ed Pre-AY 2024-2025: Natural Science
- USLO: Quantitative and Scientific Reasoning and Literacy

AS 103 Observational Astronomy (1)

Use of telescope, planetarium, and other laboratory equipment commonly used in astronomy together with selected descriptive experiments in astronomy. Prerequisite: AS 101 or AS 102 or consent of instructor.

AS 104 Life in the Universe (3)

A scientific investigation of the question "Are we alone in the universe?" Course content includes the origin and properties of stars and planets, the requirements for life, and the emergence and sustainability of civilizations. Students will complete a variety of interactive assignments and a term project. Prerequisite: None.

Course Attributes:

- Gen Ed AY 2024-2025: Scientific Reasoning and Literacy
- Gen Ed Pre-AY 2024-2025: Natural Science
- USLO: Quantitative and Scientific Reasoning and Literacy

AS 201 Introduction to Astro Photography (1)

Photographic procedures and techniques peculiar to astronomical photography. Prerequisite: Consent of instructor.

AS 251 General Astronomy (3)

A review of the key ideas and discoveries in astronomy at the intermediate level. Prerequisite: AS 101 or AS 102, and MA 116 with a grade of C or better, or consent of instructor.

AS 360 Research in Astronomy (1-2)

Research in any of the fields of astronomy/astrophysics. Prerequisite: Consent of instructor.

AS 370 Special Subjects/Astronomy (1-5)

Material to be chosen according to student interest from any one of a number of astronomical subjects. Offered on demand as teaching schedules permit. Prerequisite: Consent of instructor.

EG 103 Physics & Engineering Seminar I (1)

An overview of the fields and practice of physics and engineering. Students will participate in weekly readings and discussions, and complete at least one written piece and at least one presentation. Specific content will change each time the course is offered.

EG 105 Introduction to Engineering (3)

Introduction to the professional role of an engineer with an orientation to the academic requirements of engineering studies, responsibilities of engineering students and professionals, discussion of various engineering careers, job site duties, professional development and registration and engineering ethics. Included are problem definition and solution, engineering design and terminology and the role of technology and its influence on society.

EG 116 Engineering Graphics (3)

Elements of geometry of engineering drawing with emphasis on spatial visualization and applications. Freehand sketching, dimensioning, and graphs. Computer aided design and engineering analysis.

EG 250 Engineering Mechanics: Statics (3)

Vector notation; resultants of force systems; analysis of force systems in equilibrium including beams, frames and trusses; analysis of systems involving friction forces; determination of centroids, centers of gravity, second moments of areas, moments of inertia. Prerequisites: MA 151 and PS 281.

EG 303 Physics & Engineering Seminar II (1)

An overview of the fields and practice of physics and engineering. Students will participate in weekly readings and discussions, and complete at least one written piece and at least one presentation. Specific content will change each time the course is offered. Prerequisite: upper-division standing

EG 320 Engineering for STEM Educators (3)

Designed to introduce concepts and applications of engineering to STEM educators. Course will explore various experimental, analysis, and design situations to develop knowledge about how objects work together to perform a function. Experiments will develop an understanding of basic engineering concepts such as motion, solid mechanics, fluid mechanics, thermodynamics, electricity, and magnetism. Analysis of experiments will provide recognition of experimental variables and their relationships to mathematical equations. Significant emphasis is on conceptual understanding of how mathematics and physics work together to solve engineering problems. This course does not satisfy any engineering prerequisite/requirement outside of the STEM education program. Prerequisite: BI 319 Biology for STEM Educators with a "C" or better; concurrent enrollment in MA 320 Mathematics for Middle School Teachers.

EG 351 Engineering Mechanics: Dynamics (3)

Displacement, velocity, and acceleration of a particle; relation between forces acting on rigid bodies and the changes in motion produced; translation; rotation; motion in a plane; solutions using the principles of force, mass and acceleration, work and energy, and impulse and momentum. Prerequisites: EG 250 and MA 152.

EG 360 Mechanics of Materials (3)

Elementary theories of stress and strain, behavior of materials, and applications of these theories and their generalizations to the study of stress distribution, deformation, and instability in the simple structural forms that occur most frequently in engineering practice. Prerequisites: EG 250 and MA 253.

GL 101 Physical Geology (3)

Special emphasis on the observation of the phenomena of erosion, mountain formation, and stream and glacial action. Lecture-recitation and some field trips.

Course Attributes:

- Gen Ed AY 2024-2025: Scientific Reasoning and Literacy
- Gen Ed Pre-AY 2024-2025: Natural Science
- USLO: Quantitative and Scientific Reasoning and Literacy

GL 103 Historical Geology (3)

For students interested in the history and evolution of the planet Earth. Lecture and in-class laboratory work will include exercises with commonly found fossils and geologic-topographic maps. Will provide information about the environment of the early Earth and changes through time.

Course Attributes:

- Gen Ed AY 2024-2025: Scientific Reasoning and Literacy
- Gen Ed Pre-AY 2024-2025: Natural Science
- USLO: Quantitative and Scientific Reasoning and Literacy

PS 101 Physics in Everyday Life (5)

An integrated lecture and laboratory course designed for people pursuing degrees outside the natural or health sciences and who are interested in understanding how physics forms the backdrop of modern life. Topics include motion, gravity, energy, heat, sound, light, electricity, and magnetism, discussed in terms of impact on modern society and everyday life. Laboratory exercises demonstrate physical concepts while emphasizing the scientific process of data collection and analysis. This course requires no previous science or mathematics background and cannot count towards Physics Department degree programs. Fulfills the general education requirement of a natural science course with lab. Course consists of three hours of lecture and three hours of laboratory exercises per week. Prerequisites: None.

Course Attributes:

- Gen Ed AY 2024-2025: Natural and Physical Sciences
- Gen Ed AY 2024-2025: Scientific Reasoning and Literacy
- Gen Ed Pre-AY 2024-2025: Natural Science
- USLO: Quantitative and Scientific Reasoning and Literacy

PS 103 Physics & Engineering Seminar I (1)

An overview of the fields and practice of physics and engineering. Students will participate in weekly readings and discussions, and complete at least one written piece and at least on presentation. Specific content will change each time the course is offered.

PS 108 Physical Science (3)

Introduces basic physics and chemistry with an emphasis on the understanding and significance of accepted fundamental principles. It provides an opportunity to develop critical thinking suited to pursuing any science, as well as giving a larger perspective than can be obtained by study of a single science. Explores contemporary issues as well as the methods, limitations, and societal implications of scientific advancement. Students will be encouraged to explore the relationship between science and everyday life. For non-majors. Recommended for partial fulfillment of the graduation requirement in natural science. Prerequisite: MA 112 Essential Mathematics or MA 116 College Algebra or higher, or concurrent enrollment.

Course Attributes:

- Gen Ed AY 2024-2025: Scientific Reasoning and Literacy
- Gen Ed Pre-AY 2024-2025: Natural Science
- USLO: Quantitative and Scientific Reasoning and Literacy

PS 120 Meteorology (3)

The Earth's atmosphere and basic circulation patterns including types and classification of clouds and air masses, the formation of fronts, winds aloft computations, principles of forecasting, energy considerations and other associated physical processes. Prerequisite: MA 095 or higher.

Course Attributes:

- Gen Ed AY 2024-2025: Scientific Reasoning and Literacy
- Gen Ed Pre-AY 2024-2025: Natural Science
- USLO: Quantitative and Scientific Reasoning and Literacy

PS 126 Physical Science for Elementary Educators (5)

This course introduces the fundamentals of physics and chemistry, for the pre-service elementary school teacher. The course features lab-based, hands-on activities, and collaborative, inquiry-based exercises. Course activities serve to improve confidence in both scientific process and content learning, with methods applicable to elementary curricula.

Course Attributes:

- Gen Ed AY 2024-2025: Natural and Physical Sciences
- Gen Ed AY 2024-2025: Scientific Reasoning and Literacy
- Gen Ed Pre-AY 2024-2025: Natural Science
- USLO: Quantitative and Scientific Reasoning and Literacy

PS 131 Biological Physics for the Health and Life Sciences (3)

A one-semester course covering classical and modern physics, designed primarily for students in the health professions. Typical subjects include the laws of motion, gravity, heat, sound, light, electricity, and magnetism. Subjects are treated conceptually along with the use of basic data. Recommended for partial fulfillment of the graduation requirement in natural science. Not applicable toward credit for physics major requirements. Students will not receive credit for both PS 101 and PS 131. Prerequisite: MA 112 Essential Mathematics or MA 116 College Algebra or higher, or concurrent enrollment.

Course Attributes:

- Gen Ed AY 2024-2025: Scientific Reasoning and Literacy
- Gen Ed Pre-AY 2024-2025: Natural Science
- USLO: Quantitative and Scientific Reasoning and Literacy

PS 132 Biological Physics for the Health and Life Sciences Laboratory (1)

A laboratory exploring classical and modern physics, designed primarily for students in the health professions. Experiments in motion, gravity, heat, sound, light, electricity, and magnetism are designed to teach physics concepts and basic laboratory techniques. The course is designed to introduce students to laboratory techniques used in physics emphasizing instrumentation, data acquisition, and analysis. One three-hour laboratory period per week. Recommended for partial fulfillment of the graduation requirement in natural science. Not applicable toward credit for physics major requirements. Prerequisite: PS 131 Biological Physics for the Health and Life Sciences or concurrent enrollment. Concurrently enrolled students may not drop PS 131 and remain enrolled in PS 132.

PS 261 College Physics I (5)

Recommended for medical arts and general science students. Mechanics, heat, and sound are studied. Lecture-recitation and laboratory. Prerequisite: MA 117 or MA 123 or MA 151 (or concurrent). Course Attributes:

- Gen Ed AY 2024-2025: Natural and Physical Sciences
- Gen Ed AY 2024-2025: Scientific Reasoning and Literacy
- Gen Ed Pre-AY 2024-2025: Natural Science
- USLO: Quantitative and Scientific Reasoning and Literacy

PS 262 College Physics II (5)

A continuation of College Physics I. Electricity, optics and modern physics. Lecture-recitation and laboratory. Prerequisite: PS 261 with a grade of C or better.

PS 281 General Physics I (5)

Required for students who wish to major in physics and astronomy and for pre-engineering students. Mechanics, heat, and sound are studied. Lecture-recitation and laboratory. Prerequisite: MA 151.

Course Attributes:

- Gen Ed AY 2024-2025: Natural and Physical Sciences
- Gen Ed AY 2024-2025: Scientific Reasoning and Literacy
- Gen Ed Pre-AY 2024-2025: Natural Science
- USLO: Quantitative and Scientific Reasoning and Literacy

PS 282 General Physics II (5)

A continuation of General Physics I. Electricity and magnetism, optics, and modern physics. Lecture-recitation and laboratory. Prerequisite: PS 281 with a grade of C or better.

PS 291 Elementary Computational Physics (2)

An introduction to computer modeling of physics problems using spreadsheet programs, computer algebra systems, and other mathematical software. Prerequisite: MA 151 or concurrent.

PS 303 Physics & Engineering Seminar II (1)

An overview of the fields and practice of physics and engineering. Students will participate in weekly readings and discussions, and complete at least one written piece and at least one presentation. Specific content will change each time the course is offered. Prerequisite: upper-division standing

PS 310 Relativity (2)

Concepts of space and time, frames of reference, Einstein's Theory of Special Relativity and Elements of General Relativity. Prerequisite: PS 262 or PS 282; MA 253.

PS 318 Earth and Space Science for STEM Educators I (3)

Designed to introduce the history, structure, composition, and dynamic processes that shape our planet, as well as the impact humans have on Earth's resources, to STEM educators. Connects astronomy and geology through the study of planetary science and exploration. This course does not satisfy any physics requirement outside of the STEM education program. Prerequisites: CH 317 with a letter grade of C or higher; concurrent enrollment in ED 318.

PS 320 Electromagnetic Theory I (3)

The basic theory of electro-magnetic fields and waves using the calculus and vector methods. Prerequisites: PS 262 or PS 282; MA 253.

PS 321 Electromagnetic Theory II (3)

A continuation of Physics 320. Prerequisite: PS 320.

PS 322 Circuits and Electronics (3)

Design and applications of DC and AC circuits along with electrical measurement and analysis. Topics include filters, complex impedance, Fourier analysis, and semiconductor devices. Two lecture hours and three laboratory hours per week. Prerequisite: PS 262 or PS 282.

PS 330 Optics (3)

Physical and geometrical optics. Lecture-recitation. Prerequisite: PS 262 or PS 282.

PS 332 Optics Lab (1)

Experiments with lens systems, mirrors, aberrations, the spectrometer, interference and diffraction, and polarization. Prerequisite: PS 330 or concurrent enrollment.

PS 334 Thermodynamics (3)

Consideration of heat phenomena, first and second laws of thermodynamics, their principal consequences and application to simple systems, and the kinetic theory of gases. Prerequisite: PS 262 or PS 282; MA 253.

PS 335 Theoretical Mechanics I (3)

A mathematical study of classical mechanics. Rigid body statics and dynamics, kinematics and dynamics of particles and systems of particles, and conservative and non-conservative force fields. Prerequisites: PS 262 or PS 282; MA 253.

PS 336 Theoretical Mechanics II (3)

A continuation of Theoretical Mechanics I. Prerequisite: PS 335.

PS 340 Computer Interfacing and Instrumentation (3)

Design and implementation of scientific instruments via computer interfacing, emphasizing both software and hardware considerations. LabVIEW and Arduino platforms are used specifically. Two lecture hours and one three-hour laboratory per week. Prerequisites: PS 262 or PS 282

PS 350 Modern Physics I (3)

Phenomena specific to the extra-nuclear structure of the atom; phenomena peculiar to the atomic nucleus; introduction to quantum and wave mechanics, and relativity. Prerequisites: PS 262 or PS 282; MA 253.

PS 351 Modern Physics II (3)

A continuation of Physics 350. Prerequisite: PS 350.

PS 352 Modern Physics Laboratory (1)

Measurements of constants fundamental to atomic physics: Planck's constant, electron charge and mass, speed of light, etc. Techniques of nuclear alpha, beta and gamma ray spectroscopy. Prerequisite: PS 350.

PS 360 Physics Research (1, 2)

Experimental design and techniques. Extensive use of technical literature will be necessary. Independent work is encouraged. This Capstone requires summative reflection, serving as a culminating experience for Bachelor's degree students. Prerequisite: Consent of instructor.

PS 365 Introduction to Theoretical Physics (3)

Application of ordinary and partial differential equations, Fourier series and Transforms, partial differential equations with solution methods, and tensor analysis as applied to problems in the fields of physics and engineering. Prerequisites: PS 262 or PS 282 or concurrent enrollment; MA 253.

PS 366 Introduction to Computational Physics (3)

Techniques and models in computational physics. Prerequisites: PS 262 or PS 282; MA 253.

PS 368 Computational Physics Research (1)

Computational physics research in any of the areas of physics. A written and an oral presentation of the work is required. This Capstone requires summative reflection, serving as a culminating experience for Bachelor's degree students. Prerequisite: Departmental permission.

PS 370 Special Subjects in Physics (1-3)

Offered on demand as teaching schedules permit. Material is to be chosen according to student interest from any one of a number of fields of physics. Prerequisite: consent of instructor.