PHYSICS AND
ASTRONOMY

Phillips 230
715-836-3148
Department Website (https://www.uwec.edu/academics/college-arts-sciences/departments-programs/physics-astronomy)

Physics, the science of matter and energy, is the study of the deepest mysteries of our universe, ranging from subatomic particles to cosmology. Exploring ideas of space, time, matter, energy, and radiation, it serves as the basis for the physical sciences. Modern society is influenced by physics in countless ways, including recent developments in such fields as laser optics, miniaturized electronics, nuclear energy, and medical instrumentation.

Beyond the earth, astronomy applies the ideas of physics to the study of planets, stars, galaxies and all celestial phenomena within reach of our telescopes. Since the two areas share a vast array of common ideas and knowledge, new discoveries in physics often aid progress in astronomy and vice versa.

Special learning opportunities associated with the department include the Materials Science + Engineering Center (https://www.uwec.edu/academics/college-arts-sciences/departments-programs/materials-science-engineering/materials-science-engineering-center), the L.E. Phillips Planetarium, and Hobbs Observatory at the Beaver Creek Reserve (https://www.beavercreekreserve.org).

Departmental Honors in Physics
Departmental Honors is a way for a student to experience the thrill of innovative research and discovery in an area of interest within Physics and Astronomy. One of the most significant benefits of Departmental Honors is that it fosters one-on-one interaction between students and professors, which substantially enhances a student’s educational experience and serves as a springboard for excellence in graduate studies or professional employment after graduation.

Eligibility: Complete PHYS 332 and maintain both a resident GPA and a major GPA of at least 3.50.

Procedure: A written application for Departmental Honors in Physics and Astronomy must be approved by the student’s academic advisor, the student’s project advisor, and the chair of the Physics and Astronomy Department.

Requirements:
1. Complete the required courses for one of the three emphases for the Liberal Arts major in Physics.
2. Complete two courses selected from among
   - PHYS 367 Astrophysics 3
   - PHYS 375 Electromagnetic Fields 4
   - PHYS 430 Advanced Laboratory Techniques 2
   - PHYS 445 Thermal Physics 4
   - PHYS 465 Quantum Mechanics 3
3. Complete a significant scholarly activity and disseminate the results of the activity by completing a written research paper and presenting at an appropriate on-campus or off-campus venue (Physics Thursday, CERCA, Provost’s Honors Symposium, etc.) or making a presentation at a professional meeting or publishing an article in a professional journal.

The quality of the activity and dissemination will be evaluated by a three-member faculty panel. Upon approval by the panel, the student will receive the designation of Departmental Honors in Physics and Astronomy on his/her official transcript and a special notation in the graduation ceremony program.

Faculty
J. Erik Hendrickson, Chair
Douglas Dunham
Matthew Evans
Lyle Ford
Lauren Likkel
Nathan Miller
Kim Pierson
James Rybicki
George Stecher
Paul Thomas
Scott Whitfield
William Wolf

Majors
- Major: Physics, Liberal Arts - B.A./B.S.
- Major: Physics, Applied Physics Emphasis, Liberal Arts - B.A./B.S.
- Major: Physics, Dual Degree Engineering Emphasis, Liberal Arts - B.A./B.S.
- Major: Physics, Teaching - B.S.
- Major: Physical Science, Teaching - B.S. (Interdisciplinary Major)
- Major: Physics-Mathematics, Teaching - B.S. (Interdisciplinary Major)

Minors
- Minor: Physics, Liberal Arts
- Minor: Physics, Teaching

Certificates
- Certificate: LabVIEW

PHYS 100 Physical Science (4 crs)
Prerequisite: No credit if taken after PHYS 110, PHYS 111, PHYS 211 or PHYS 231.
A conceptual study of physics using ideas of force and energy to understand motion, properties of matter, sound, light, and electricity and magnetism.

Attributes: GE IIE Natural Science-Physics, Lab Science, LE-K1 Natural Sciences, LE-K1L Natural Sciences with Lab
Lecture/Discussion Hours: 3
Lab/Studio Hours: 2

PHYS 115 Survey of Astronomy (3 crs)
Prerequisite: No credit if taken after PHYS 226 or PHYS 229.
A one-semester presentation of our current understanding of the universe, including the solar system, birth and death of stars, unusual phenomena such as black holes and quasars, evolution of galaxies and the universe, and our link with the cosmos.

Attributes: GE IIE Natural Science-Physics, Lab Science, LE-K1 Natural Sciences, LE-K1L Natural Sciences with Lab
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0
PHYS 186 Introductory Seminar (0.5 crs)
Prerequisite: Limited to physics liberal arts majors.
Students will explore avenues for obtaining an internship, discuss plans for participating in the required research project, attend the weekly Physics Seminar, develop academic plans, and participate in postgraduate planning.
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: .5
Lab/Studio Hours: 0

PHYS 205 Physics of Renewable Energy (4 crs)
Explores the basic physics principles behind various types of renewable energy sources. Discusses impact renewable energy sources have on mitigating global warming and climate change.
Attributes: GE IIE Natural Science-Physics, Lab Science, LE-K1 Natural Sciences, LE-K1L Natural Sciences with Lab, LE-R3 Civic and Environmental Issues
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 3
Lab/Studio Hours: 2

PHYS 211 General Physics (5 crs)
Prerequisite: No credit if taken after PHYS 231.
Fundamental principles of mechanics, heat, wave motion, and sound. Designed for students who desire a one-year non-calculus course in physics. Proficiency with algebraic and trigonometric operations is expected.
Attributes: GE IIE Natural Science-Physics, Lab Science, LE-K1 Natural Sciences, LE-K1L Natural Sciences with Lab
Lecture/Discussion Hours: 4
Lab/Studio Hours: 2

PHYS 212 General Physics (4 crs)
Prerequisite: PHYS 211. No credit if taken after PHYS 232.
A continuation of Physics 211 including topics in optics, electricity, magnetism, and modern physics.
Attributes: GE IIE Natural Science-Physics, Lab Science
Lecture/Discussion Hours: 3
Lab/Studio Hours: 2

PHYS 226 Astronomy-Solar System (4 crs)
- Three years high school mathematics assumed prior to enrollment in this course. Some night observing required.
The physical nature of the solar system, including earth motions, celestial coordinates, time, telescopes, moon, planets, sun, and origin of solar system.
Attributes: GE IIE Natural Science-Physics, Lab Science, LE-K1 Integration, LE-K1 Natural Sciences, LE-K1L Natural Sciences with Lab
Lecture/Discussion Hours: 3
Lab/Studio Hours: 2

PHYS 229 Astronomy-Stars and Galaxies (4 crs)
- Three years of high school mathematics assumed prior to enrollment in this course. PHYS 226 is not a prerequisite. Some night observing required.
The physical nature of the universe, including stellar evolution, multiple and variable stars, the Milky Way galaxy, other galaxies, and origin of the universe.
Attributes: GE IIE Natural Science-Physics, Lab Science, LE-K1 Natural Sciences, LE-K1L Natural Sciences with Lab
Lecture/Discussion Hours: 3
Lab/Studio Hours: 2

PHYS 231 University Physics I (5 crs)
Prerequisite: MATH 114 or concurrent enrollment.
Physics for science and engineering students, including the study of mechanics, simple harmonic motion, and wave motion.
Attributes: GE IIE Natural Science-Physics, Lab Science, LE-K1 Natural Sciences, LE-K1L Natural Sciences with Lab
Lecture/Discussion Hours: 4
Lab/Studio Hours: 2

PHYS 232 University Physics II (5 crs)
Prerequisite: PHYS 231; MATH 215 or concurrent enrollment
A continuation of Physics 231, including the study of electricity, magnetism, and optics.
Attributes: GE IIE Natural Science-Physics, Lab Science, LE-K1 Natural Sciences, LE-K1L Natural Sciences with Lab
Lecture/Discussion Hours: 4
Lab/Studio Hours: 2

PHYS 255 Statics (3 crs)
Prerequisite: PHYS 231; MATH 215 or concurrent registration.
Designed primarily for pre-engineering students. Includes static equilibrium of rigid bodies, centroids, analysis of structures, friction, and moments of inertia.
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

PHYS 291 Special Topics (1-3 crs)
Content will be determined by the interests of students and faculty. May contain lecture or lab.

PHYS 308 Science of Musical Sound (3 crs)
Physical concepts related to production of tones and speech. Application to musical instruments and auditorium acoustics, with experimental demonstrations of vibrational phenomena and electronic sound analysis and synthesis. No prior physics or university mathematics assumed.
Attributes: GE IIE Natural Science-Physics, LE-K1 Natural Sciences
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites</th>
<th>Description</th>
<th>Attributes</th>
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<tr>
<td>PHYS 315</td>
<td>The Mysterious Universe (3 crs)</td>
<td>3</td>
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<td>A view of the world as revealed by contemporary physical thought. Topics include size and origin of universe, ultimate nature of matter; modern ideas of space, time and energy; possibilities of extraterrestrial life; and values and limitations of science.</td>
<td>GE IIE Natural Science-Physics, LE-I1 Integration, LE-K1 Natural Sciences</td>
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<td>PHYS 332</td>
<td>University Physics III (3 crs)</td>
<td>3</td>
<td>PHYS 232 and MATH 215.</td>
<td>Physics for science and engineering students, including the study of fluids, heat, thermodynamics, relativity, and an introduction to modern physics.</td>
<td>LE-I1 Integration</td>
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<td>PHYS 333</td>
<td>Quantum Physics (3 crs)</td>
<td>3</td>
<td>PHYS 332 and MATH 216.</td>
<td>Introduction to the experimental and theoretical basis of quantum physics, including particle aspects of radiation, matter waves, Bohr model of the atom, Schrodinger wave mechanics and its application to the hydrogen atom and multi-electron atoms.</td>
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<td>PHYS 340</td>
<td>Optics (4 crs)</td>
<td>4</td>
<td>PHYS 232 and MATH 215.</td>
<td>Lecture and laboratory work cover geometrical and physical optics, image formation, optical instruments, interference, diffraction, polarization, and modern topics including lasers.</td>
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<td>PHYS 350</td>
<td>Electric and Electronic Circuits (4 crs)</td>
<td>4</td>
<td>MATH 215 and grade of C or above in PHYS 232.</td>
<td>General introduction to electrical circuits and electronics including analysis of DC and AC circuits, simple passive filters, diodes, transistors, operational amplifiers, simple digital electronics, and circuit design and construction.</td>
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<td>PHYS 366</td>
<td>Dynamics (3 crs)</td>
<td>3</td>
<td>MATH 215 and PHYS 255 (or MATH 255). No credit if taken after MATH 256. Credit may not be earned in both PHYS 356 and PHYS 365.</td>
<td>A continuation of Physics 255. Dynamics of rigid bodies, moments of inertia, work, energy, impulse, and momentum.</td>
<td>A-F Grades Only</td>
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<td>PHYS 360</td>
<td>Electronics (4 crs)</td>
<td>4</td>
<td>PHYS 350 or consent of instructor.</td>
<td>Description, analysis, and laboratory measurements of digital and analog devices including transistor amplifiers, operational amplifiers, oscillators, gates, flip-flops, analog-digital converters, and microprocessors.</td>
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<td>PHYS 361</td>
<td>LabVIEW Basics (2 crs)</td>
<td>2</td>
<td>PHYS 350 or concurrent enrollment.</td>
<td>Lecture and laboratory work cover an introduction to the graphical programming language LabVIEW. LabVIEW has been widely adopted as the industry standard for computerized data acquisition, analysis and instrument control.</td>
<td>Undergraduate/Graduate Offering, Field trip(s) optional.</td>
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<td>PHYS 362</td>
<td>LabVIEW Applications (2 crs)</td>
<td>2</td>
<td>PHYS 361 LabVIEW Basics</td>
<td>Lecture and laboratory exercises cover applications using the graphical programming language LabVIEW. Topics include advanced programming structures, CompactDAQ hardware, digital signal processing, motor control, encoders, PID process control, RS-232 instrument control, component testing, sensor monitoring.</td>
<td>Undergraduate/Graduate Offering, Field trip(s) optional.</td>
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<td>PHYS 363</td>
<td>LabVIEW cRIO (1 cr)</td>
<td>1</td>
<td>PHYS 362 LabVIEW Applications</td>
<td>Lecture and laboratory exercises cover the theory and application of the cRIO automation controller using the graphical programming language LabVIEW. Topics include Real-Time operating system, field programmable gate array (FPGA) and network shared variables.</td>
<td>Undergraduate/Graduate Offering</td>
<td>1</td>
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<td>PHYS 365</td>
<td>Theoretical Mechanics (4 crs)</td>
<td>4</td>
<td>MATH 216, and a grade of C or above in PHYS 231. Credit may not be earned in both PHYS 356 and PHYS 365.</td>
<td>Newton’s laws, accelerated frames, central-force orbits, angular momentum of systems, coupled oscillations, generalized coordinates, and Lagrange’s equations. Lecture/Discussion Hours: 4 Lab/Studio Hours: 0</td>
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<td>PHYS 367</td>
<td>Astrophysics (3 crs)</td>
<td>3</td>
<td>PHYS 332</td>
<td>Physics applied to astronomical objects. The birth, structure, and evolution of stars are studied in detail. Nebulae, the interstellar medium, and stellar remnants are also investigated. Lecture/Discussion Hours: 3 Lab/Studio Hours: 0</td>
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<td>PHYS 374</td>
<td>Physics of Solids (4 crs)</td>
<td>4</td>
<td>PHYS 332 or MSE 350.</td>
<td>A description of the behaviors of crystalline solids. Topics include crystallography, diffraction, and the electrical, optical and magnetic properties of materials. Semiconducting materials and devices will also be discussed. Lecture/Discussion Hours: 4 Lab/Studio Hours: 0</td>
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<td>PHYS 375</td>
<td>Electromagnetic Fields (4 crs)</td>
<td>4</td>
<td>PHYS 332, MATH 216, and MATH 311 or MATH 312.</td>
<td>Electric and magnetic fields, dielectric and magnetic properties of materials, and electromagnetic phenomena. Field theory leading to the development of Maxwell’s equations and the plane electromagnetic wave. Lecture/Discussion Hours: 4 Lab/Studio Hours: 0</td>
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<td>PHYS 399</td>
<td>Independent Study - Juniors (1-3 crs)</td>
<td>1-3</td>
<td>Minimum junior standing. Consent: Department Consent Required</td>
<td>Individual project under the direction of a faculty member. Repeat: Course may be repeated</td>
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<td>PHYS 430</td>
<td>Advanced Laboratory Techniques (2 crs)</td>
<td>2</td>
<td>Two courses from PHYS 340, PHYS 350, PHYS 360.</td>
<td>Laboratory course for students with special interests in experimental physics. The emphasis is on widely applicable modern experimental methods. Lecture/Discussion Hours: 0 Lab/Studio Hours: 4</td>
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<td>PHYS 440</td>
<td>Digital Image Processing (3 crs)</td>
<td>3</td>
<td>MATH 215</td>
<td>Applications of Fourier analysis and wavelets to optics and image processing. Topics include: diffraction, wave optical theory of lenses and imaging, wavelets, and image processing. Lecture/Discussion Hours: 3 Lab/Studio Hours: 0</td>
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<td>PHYS 445</td>
<td>Thermal Physics (4 crs)</td>
<td>4</td>
<td>PHYS 332 and MATH 216. No credit if taken after PHYS 334 and PHYS 435.</td>
<td>Statistical mechanics and thermodynamics including the laws of classical thermodynamics, equations of state, thermodynamical processes, and applications to classical and quantum mechanical systems. Lecture/Discussion Hours: 4 Lab/Studio Hours: 0</td>
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<td>PHYS 465</td>
<td>Quantum Mechanics (3 crs)</td>
<td>3</td>
<td>PHYS 333, MATH 311 or MATH 312.</td>
<td>A continuation of Physics 333, including Dirac notation, operator methods, one dimensional potentials, spin and angular momentum, and the philosophical interpretation of quantum mechanics. Lecture/Discussion Hours: 3 Lab/Studio Hours: 0</td>
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<td>PHYS 486</td>
<td>Senior Seminar (0.5 crs)</td>
<td>0.5</td>
<td>Limited to physics liberal arts majors, liberal arts emphasis; and physics liberal arts majors, applied physics emphasis. Consent: Department Consent Required</td>
<td>Students will present a capstone project seminar, develop presentation skills (oral and poster), take a nationally normed test covering undergraduate physics, discuss their post-graduate plans, and assist the department in assessing the major. Attributes: LE-S3 Creativity Lecture/Discussion Hours: .5 Lab/Studio Hours: 0</td>
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<td>PHYS 491</td>
<td>Special Topics (1-4 crs)</td>
<td>1-4</td>
<td>PHYS 333 and PHYS 365.</td>
<td>Content will be determined by the interests of students and faculty. Possible topics include astrophysics and solid state physics. Repeat: Course may be repeated for a maximum of 6 credits</td>
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PHYS 495 Directed Study (1-3 crs)
Prerequisite: PHYS 332; 2.75 GPA in physics. Limited to physics majors and minors.
Consent: Department Consent Required
• Limit of three credits counted toward major.

Special project or research activity, primarily on campus, and directed by a faculty member. Projects and topics available will be determined by the activities and interests of the faculty.
Repeat: Course may be repeated for a maximum of 6 credits

PHYS 499 Independent Study - Seniors (1-3 crs)
Prerequisite: Minimum senior standing.
Consent: Department Consent Required
Individual project under the direction of a faculty member.
Repeat: Course may be repeated

PHYS 561 LabVIEW Basics (2 crs)
Consent: Instructor Consent Required
• Cross-listed with PHYS 361. Credit may not be earned in both courses. Field trip(s) optional.

Lecture and laboratory work cover an introduction to graphical programming language LabVIEW. LabVIEW has been widely adopted as the industry standard for computerized data acquisition, analysis and instrument control.
Attributes: Field Trip(s) Required
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 2
Lab/Studio Hours: 0

PHYS 562 LabVIEW Applications (2 crs)
Consent: Instructor Consent Required
• Cross-listed with PHYS 362. Credit may not be earned in both courses. Field trip(s) optional.

Lecture and laboratory exercises cover applications using the graphical programming language Lab VIEW. Topics include advanced programming structures, Compact DAQ hardware, digital signal processing, motor control, encoders, PID Process control, RS-232 instrument control, component testing, sensor monitoring.
Attributes: Field Trip(s) Required
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 2
Lab/Studio Hours: 0

PHYS 563 LabVIEW cRIO (1 cr)
Consent: Instructor Consent Required
• Cross-listed with PHYS 363. Credit may not be earned in both courses.

Lecture and laboratory exercises cover the theory and application of the cRIO automation controller using the graphical programming language LabVIEW. Topics include Real-Time operating system, field programmable gate array (FPGA) and network shared variables.
Attributes: Field Trip(s) Required
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 1
Lab/Studio Hours: 0

PHYS 563 Directed Studies (1-4 crs)
Permits groups of students to study topical areas in an intensive way under the direction of departmental faculty members.
Repeat: Course may be repeated
Grading Basis: No S/U Grade Option