GUIDE FOR PHYSICS MAJORS & MINORS

THE UNIVERSITY OF TENNESSEE KNOXVILLE

OUR DEPARTMENT

How stars are born, cells divide, and electricity works isn't random. Natural laws such as gravity govern these phenomena. Physicists develop theories and models to understand how those principles show up in our world and beyond. Fundamental research like this revealed the atom, its structure and component particles (including electrons), and how those particles interact. The tools physicists develop often evolve into technologies that end up in everyday life, from medical imaging to touch screens. A physics degree from the University of Tennessee, Knoxville, (**physics.utk.edu**) equips students with the problem-solving skills they need to adapt to the ever-changing nature of science and technology and shows them how to translate those skills into broad career opportunities.

THE PHYSICS MAJOR

The department offers BS and BA degree tracks, as well as minors in both physics and astronomy.

Bachelor of Science

The BS program offers two concentrations to prepare students for exciting careers in physics and technology. The **academic concentration** provides all courses needed for students to pursue graduate studies in physics, while the **astronomy concentration** expands opportunities for students interested in astronomy and astrophysics career paths.

Bachelor of Arts

The BA degree program has the same foundational courses as the BS, but offers more flexibility for students who wish to apply physics to other fields like chemistry, math, education, law, medicine, or journalism.

DEPARTMENTAL HONORS

Each year the department awards distinctive honors to undergraduates who excel in scholarship, research, and leadership. Honors include the Outstanding First Year Physics Student Award, the Douglas V. Roseberry Distinguished Upper Class Major Award, the James W. McConnell Award, and the Robert Talley Awards for Outstanding Undergraduate Research and Leadership. Our honorees have joined physics graduate programs at Yale, Harvard, the University of Chicago, the University of Washington, and Michigan State University, amongst others.

RESEARCH

Physics and Astronomy students have multiple opportunities to perform cutting-edge research with our expert faculty for both credit and pay. There are current opportunities in astrophysics, biophysics, condensed matter physics (including quantum materials), elementary particle/high energy physics, and nuclear physics, leading to student co-authorship on scientific publications. Students work on campus (including at the Center for Advanced Materials and Manufacturing—CAMM) as well as at Oak Ridge National Laboratory, Fermilab, CERN, and RIKEN in Japan. The department's Summer Research Fellowship program gives outstanding undergraduates the opportunity to gain experience by spending 10 weeks working on a paid full-time research project supervised by a physics faculty member.

DEGREE REQUIREMENTS

Note: These are the **physics, math, and computer science** course requirements for a bachelor's degree in physics. **Consult the *Undergraduate Catalog*** for a complete list of degree requirements and choices for electives, as well as requirements for degrees with an honors concentration.

	BS (ASTRONOMY)	BS (ACADEMIC)	BA
YEAR 1			
Fall	MATH 132 or 141 or 147 PHYS 135 or 137	MATH 132 or 141 or 147 PHYS 135 or 137	MATH 132 or 141 or 147 PHYS 135 or 137
Spring	PHYS 211 COSC 101 or 102 or 111 MATH 142 or 148 PHYS 136 or 138	PHYS 211 COSC 101 or 102 or 111 MATH 142 or 148 PHYS 136 or 138	PHYS 211 COSC 101 or 102 or 111 MATH 142 or 148 PHYS 136 or 138
YEAR 2			
Fall	ASTR 217, MATH 231, PHYS 251	MATH 231, PHYS 251	PHYS 251 Physics Elective (3 Credit Hours)
Spring	ASTR 218, PHYS 201, PHYS 252, PHYS 321	PHYS 201, PHYS 252, PHYS 321	PHYS 252 Physics Elective (3 Credit Hours)
YEAR 3			
Fall	ASTR 411, PHYS 301, PHYS 311	PHYS 301, PHYS 311, PHYS 361	Physics Electives (6 Credit Hours)
Spring	ASTR 421	PHYS 312, PHYS 461	Physics (Major) (3 Credit Hours)
YEAR 4			
Fall	PHYS 461 TWO Courses from: PHYS 361, 411, 421, or 431	PHYS 411, PHYS 431, Physics (Major) (3 Credit Hours)	Physics Electives (Major) (3 Credit Hours)
Spring	PHYS 451, PHYS 495	PHYS 412, PHYS 432, PHYS 451, PHYS 495	Physics Elective (3 Credit Hours)

PHYSICS MINOR

Complete one: PHYS 135, PHYS 137, EF 151 AND EF 152, PHYS 221
Complete one: PHYS 136, PHYS 138, PHYS 231, PHYS 222
Complete: PHYS 251, PHYS 252
Select 8 hours: PHYS 293, Physics and Astronomy courses numbered 300 and above.

ASTRONOMY MINOR

Complete: ASTR 217, ASTR 218, ASTR 411, ASTR 421 or ASTR 490, PHYS 252, PHYS 311, PHYS 421 or PHYS 321

PHYSICS & ASTRONOMY COURSES

Please consult the university's *Undergraduate Catalog* for full course descriptions, prerequisite and corequisite requirements, credit restrictions, etc.

ASTR 151 - A Journey through the Solar System Lecture
Study of Earth's nearest astronomical neighbors, including the sun, planets, asteroids, and comets. (3)

ASTR 152 - Stars, Galaxies, and Cosmology Lecture
Life and death of stars, exotic objects including white dwarfs, supernovae, neutron stars, pulsars, and black holes. (3)

ASTR 153 - A Journey through the Solar System Lab
Principles for interpretation of astronomical observations are reinforced in laboratory. (1)

ASTR 154 - Stars, Galaxies, and Cosmology Lab
Principles for interpretation of astronomical observations are reinforced in laboratory. (1)

ASTR 217 - Honors: Introductory Astronomy
Introduction to astronomy and astrophysics. (4)

ASTR 218 - Honors: Introductory Astronomy
Introduction to astronomy and astrophysics. (4)

ASTR 411 - Stellar Structure and Stellar Evolution
An introduction to stars and the physical principles governing stellar structure and stellar evolution. (3)

ASTR 421 - General Relativity, Black Holes, and Cosmology
An introduction to the general theory of relativity and its application to issues of current interest in astronomy and astrophysics. (3)

ASTR 490 - Special Topics in Astronomy
Topics of current interest in astronomy and astrophysics. May be repeated for credit with consent of department. (1-3)

PHYS 101 - How Things Work I
Examines familiar objects of everyday experience and leads to an understanding of the physical principles that make them work. Laws of motion, mechanical objects, fluids, and heat. For students with majors outside science. (3)

PHYS 102 - How Things Work II
Examines familiar objects of everyday experience and leads to an understanding of the physical principles that make them work. Electric and magnetic forces, electronics, lights and optics, and an introduction to modern physics. For students with majors outside science. (3)

PHYS 135 - Introduction to Physics for Physical Science and Mathematics Majors I
Calculus-based physics of mechanics, sound, waves, and thermodynamics. (4)

PHYS 136 - Introduction to Physics for Physical Science and Mathematics Majors II
Calculus-based physics of electricity, magnetism, optics. (4)

PHYS 137 - Honors: Fundamentals of Physics for Physics Majors I
Honors version of PHYS 135. For physics and engineering physics majors and qualified students from other majors. (5)

PHYS 138 - Honors: Fundamentals of Physics for Physics Majors II
Honors version of PHYS 136. For physics and engineering physics majors and qualified students from other majors. (5)

PHYS 161 - Elements of Physics for Architects and Interior Design Students
Chosen topics in physics for architecture and interior design students. Emphasizes material development by logic and lecture demonstrations. (3)

PHYS 201 - Multivariable Calculus and Vector Analysis for Physicists
Introduces multivariable calculus and vector analysis with a focus on applications in the physical sciences. (3)

PHYS 211 - Picture a Physicist: A Seminar for New Physics Majors
Topics include career options, research opportunities, and guidelines for professional behavior. (1)

PHYS 221 - Elements of Physics I
Basic physical principles and applications required in pre-medical, pre-pharmacy and pre-veterinary programs. Mechanics, heat, and wave motion. (4)

PHYS 222 - Elements of Physics II
Basic physical principles and applications required in pre-medical, pre-dental, pre-pharmacy and pre-veterinary programs. Electricity, magnetism, optics, modern physics. (4)

PHYS 231 - Fundamentals of Physics: Electricity and Magnetism
For engineers and majors in mathematics and the physical sciences. Electric and magnetic phenomena including DC and AC circuits and electromagnetic waves. (3)

PHYS 232 - Fundamentals of Physics: Wave Motion, Optics, and Modern Physics
For engineers and majors in mathematics and the physical sciences. Mechanical waves, including sound, and electromagnetic waves, geometric and physical optics, elements of special relativity, and introductory quantum physics. (4)

PHYS 250 - Fundamentals of Physics: Modern Physics
Fundamental concepts of modern physics and their applications to atomic, nuclear, particle, and condensed matter physics, with lab. (4)

PHYS 251 - Fundamentals of Physics: Waves, Optics, and the Breakdown of Classical Physics
Explores oscillations, waves, optics, and the breakdown of nineteenth century physics, and special relativity. Includes a lab component that may be incorporated in a studio physics modality. Basic scientific computing is integrated into the course. (4)

PHYS 252 - Fundamentals of Physics: Quantum Physics and Applications
Explores the fundamentals of quantum physics and applications to solid state physics, nuclear physics, particle physics, and cosmology. Includes a lab component that may be incorporated in a studio physics modality. Basic scientific computing is integrated into the course. (4)

PHYS 293 - Introduction to Research and Independent Study
Introduction to research and study in a field of particular interest with faculty guidance. (1-3)

PHYS 301 - Linear Algebra & Complex Analysis for Physicists
Introduces physics students to basic concepts of linear algebra and complex analysis. Students will understand how to work with matrices and learn how to determine the eigenvalues and eigenvectors. Introduction to some of the important aspects of complex analysis as relevant to quantum mechanics such as the residue theorem. (3)

PHYS 311 - Mechanics I
Kinematics and dynamics of single particles, systems of particles, and rigid bodies. Oscillations. Central forces. Gravitation. Includes computational methods. Required of all physics majors. (3)

PHYS 312 - Mechanics II
Lagrangian and Hamilton mechanics. Constraints. Non-inertial coordinate systems. Oscillations and normal modes. Special theory of relativity. Includes computational methods. Targeted toward students who intend to pursue graduate studies in physics. (3)

PHYS 321 - Thermal Physics
Concepts of temperature and heat. Laws of thermodynamics. Elementary statistical mechanics. Applications to physical and chemical problems. (3)

PHYS 341 - Introduction to Nuclear Physics
Introductory theoretical nuclear physics with emphasis on applied aspects. Primarily for nuclear engineering majors. (3)

PHYS 342 - Structure of Matter
Elementary solid state physics. Bonding in solids, free-electron-gas theory of metals, crystal structures, reciprocal lattice, energy bands, phonons, semiconductors and semiconductor devices, optical properties of solids, phenomenological description of superconductivity, magnetism, and other forms of broken symmetry. (3)

PHYS 361 - Electronics Laboratory
Electronic devices and instrumentation techniques in the physics laboratory. Basic analog and digital electronics, including elementary building blocks of relevance to data acquisition systems, operation amplifiers, digital-to-analog and analog-to-digital conversion, use of standard laboratory instruments, and applications of microcomputers. (3)

PHYS 393 - Course-based Undergraduate Research Experience
Collaborative research structured in a course format. Research field may vary. Students are required to complete a research project in collaboration with other students. (3)

PHYS 405 - Science, Technology, and Public Policy
The process by which public policy decisions are made is examined with an eye to the role scientists, advocacy groups, industry, researchers, national laboratories and individual citizens play in setting public policy. (3)

PHYS 411 - Introduction to Quantum Mechanics I
Fundamental principles of quantum mechanics. The Uncertainty Principle. Solutions of the Schrödinger equation in one dimension. Bound states. Angular momentum. The Hydrogen atom. Required course for all physics majors. (3)

PHYS 412 - Introduction to Quantum Mechanics II
Methods of calculation: perturbation theory, the variational principle, and the WKB approximation. Introduction to scattering theory. Quantum statistics. Applications to atomic, molecular, nuclear, and condensed matter physics. Targeted toward students who intend to pursue graduate studies in physics. (3)

PHYS 421 - Modern Optics
Transmission of light in uniform, isotropic media, reflection and transmission at interfaces. Mathematics of wave motion and interference effects. Rudiments of Fourier optics and holography. (4)

PHYS 431 - Electricity and Magnetism I
Electrostatics and magnetostatics in vacuum and in matter. Time-dependent electric and magnetic fields. Maxwell's equations. Required course for all physics majors. (3)

PHYS 432 - Electricity and Magnetism II
Methods of calculation in electrostatics and magnetostatics. Conservation laws. Potentials. Electromagnetic waves. Relativistic electrodynamics. Radiation. Targeted toward students who plan to pursue graduate studies in physics. (3)

PHYS 441 - Introduction to Computational Physics
Explores modern scientific computational techniques needed by undergraduate physics majors and minors. Incorporates an individual student semester project in computational physics and requires access to an appropriate computer for homework and the project. (3)

PHYS 451 - A Survey of Contemporary Physics
Modern physics research beyond the college textbook level. Students will be instructed in articulating the importance of basic and applied physics research to other science disciplines and the general public. Advanced topic lectures, discussions, reading assignments, and six oral presentations. Intended for physics majors. (3)

PHYS 461 - Modern Physics Laboratory
Introduction to fundamental and modern techniques in experimental physics and to the theory and practice of measurement and data analysis. Selected experiments in nuclear, atomic, molecular and solid state physics, and modern optics. (3)

PHYS 490 - Senior Seminar (1-3)

PHYS 491 - Foreign Study (3-15)

PHYS 492 - Off-Campus Study (3-15)

PHYS 493 - Research and Independent Study
Research and study in field of particular interest with faculty guidance. (1-3)

PHYS 494 - Special Topics in Physics
Topics of current interest in physics, or a particular interest to upper-level students. (1-3)

PHYS 495 - Physics Proficiency
Student will demonstrate proficiency in physics. Satisfactory/No Credit grading only. (0)

PHYS 498 - Honors Thesis in Physics
Advanced students work with faculty on research projects requiring knowledge and skills acquired in physics curriculum. A written honors thesis is defended orally before a faculty committee. (3)