

# DEPARTMENT OF PHYSICS

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Physics, the study of matter and energy, is at the root of every field of natural science and underlies all physical phenomena. The problem-solving skills learned in the study of physics are valuable even if one's career is not in a physics-related field.

The B.S. with a major in Physics provides a rigorous background in physics as a preparation for graduate studies or a career in industry. The B.A. with a major in Physics is for students who want a background in physics but plan to pursue fields of interest other than physics as a life's work.

Career opportunities for a physics major exist in a wide variety of settings—from teaching in a classroom to basic research in an industrial or government laboratory, as a self-employed consultant, or as a member of a multidisciplinary research team.

Students who enter Texas State needing mathematics at a level below MATH 2417 are urged to attend a summer session to avoid any delay in starting their physics courses.

For more information contact the College of Science and Engineering Advising Center or the departmental advisor for the Department of Physics. For information on engineering technology, electrical engineering, industrial engineering, and manufacturing engineering see the Ingram School of Engineering and Department of Engineering Technology sections of this catalog.

## Teacher Certification

Physics teacher preparation is one of the specialties of the Department of Physics. Through various peer teaching opportunities in the department, students may discover at any point during their undergraduate career that they have an interest in teaching physics at the secondary level (grades 7-12). There are multiple pathways for becoming a physics teacher, and which one is best for a particular student depends partly on the stage of degree progress at which the student identifies their interest. For those who identify a teaching interest early on, the recommended pathway is to pursue a B.S. Major in Physics (Secondary Education; Teacher Certification in Physics/Mathematics, Grades Seven Through Twelve, with Double Major in B.S. Education). This double major is required for any physics student wishing to graduate with a bachelor's degree and physics teacher certification. Students may choose to add a minor in Advanced Physics if they want to study all of the standard undergraduate physics curriculum that is offered in the regular B.S. Major in Physics. Some students choose to pursue teacher certification after graduation. In any case, the department provides customized, one-on-one advising to each future physics teacher. Students should contact the department's Faculty Undergraduate Advisor as early as possible if they are interested in pursuing physics teaching.

## Bachelor of Arts (B.A.)

- Major in Physics (<http://mycatalog.txstate.edu/undergraduate/science-engineering/physics/physics-ba/>)

## Bachelor of Science (B.S.)

- Major in Physics (<http://mycatalog.txstate.edu/undergraduate/science-engineering/physics/physics-bs/>)
- Major in Physics (Astronomy Concentration) (<http://mycatalog.txstate.edu/undergraduate/science-engineering/physics/physics-astronomy-bs/>)
- Major in Physics (Secondary Education; Teacher Certification in Physics/Mathematics, Grades Seven through Twelve, with Double Major in B.S. Education) (<http://mycatalog.txstate.edu/undergraduate/science-engineering/physics/physics-teacher-certification-physics-math-grades-7-12-bs/>)

## Minors

- Advanced Physics (<http://mycatalog.txstate.edu/undergraduate/science-engineering/physics/advanced-physics-minor/>)
- Physics

## Courses in Physics (PHYS)

### PHYS 1110. Elementary Physics Laboratory.

This course explores and illustrates some of the basic principles covered in PHYS 1310 and PHYS 1320. Corequisite: PHYS 1310 or PHYS 1320 either with a grade of "D" or better.

**1 Credit Hour. 0 Lecture Contact Hours. 2 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**TCCN:** PHYS 1105

### PHYS 1115. General Physics I Laboratory.

First of two laboratory courses in General Physics for science-related majors. The course introduces students to the basics of measurement. Topics cover mechanics and heat. Corequisite: PHYS 1315 or PHYS 1335 either with a grade of "D" or better.

**1 Credit Hour. 0 Lecture Contact Hours. 2 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**TCCN:** PHYS 1101

### PHYS 1125. General Physics II Laboratory.

This is the second of two laboratory courses in general Physics. The course introduces the students to experimental measurements and demonstration of principles of electricity, magnetism, optics, modern physics, electromagnetic waves. Corequisite: PHYS 1325 or PHYS 1345 with a grade of "D" or better.

**1 Credit Hour. 0 Lecture Contact Hours. 2 Lab Contact Hours.**

**Co-requisite(s):** PHYS 1325

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**TCCN:** PHYS 1102

### PHYS 1140. Introductory Laboratory in Astronomy.

An introduction to the constellations, the uses of telescopes, and other material relating to the study of stars and planets. This course is designed to be taken with PHYS 1340 or PHYS 1350 or those students desiring a laboratory course.

**1 Credit Hour. 0 Lecture Contact Hours. 2 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering|Lab Required

**Grade Mode:** Standard Letter

**TCCN:** PHYS 1111

**PHYS 1310. Elementary Physics.**

A non-mathematical survey of mechanics, properties of matter, heat and sound. These topics are described in a conceptual way with applications relating to the world around us. The laboratory experience may be obtained in a separate one-hour credit lab (PHYS 1110). PHYS 1310 and PHYS 1320 are designed for the liberal arts student. The order in which they are taken is not important. They are not recommended for pre-engineering students or majors and minors in science. The laboratory experience is recommended with the second course.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Life & Phys Sciences Core 030|Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**TCCN:** PHYS 1305

**PHYS 1315. General Physics I.**

This is the first course in a two semester sequence which is a survey of the basic laws and principles of physics and includes the topics of mechanics and heat. The course is designed for students whose program requires technical physics, but who are not pre-engineering students or majors or minors in physics. Prerequisite: [MATH 1315 or MATH 1317 or MATH 2321 or MATH 2417 or MATH 2471 with a grade of "C" or better] or [ACT Mathematics score of 24 or better] or [SAT Mathematics score of 520 or better] or [SAT Math section score of 550 or better] or [Next-Generation Advanced Algebra and Functions Test score of 263 or better]. Corequisite: PHYS 1115 with a grade of "D" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Co-requisite(s):** PHYS 1115

**Course Attribute(s):** Life & Phys Sciences Core 030|Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**TCCN:** PHYS 1301

**PHYS 1320. Elementary Physics.**

A non-mathematical survey of electricity, magnetism, light, relativity, and atomic and nuclear physics. These topics are described in a conceptual way with applications relating to the world around us. The laboratory experience may be obtained in a separate one-hour credit lab (PHYS 1110). PHYS 1310 and PHYS 1320 are designed for the liberal arts student. The order in which they are taken is not important. They are not recommended for pre-engineering students or majors and minors in science. The laboratory experience is recommended with the second course.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Life & Phys Sciences Core 030|Dif Tui- Science & Engineering|Lab Required

**Grade Mode:** Standard Letter

**TCCN:** PHYS 1307

**PHYS 1325. General Physics II.**

This is the second course in a two semester sequence which is a survey of the basic laws and principles of physics and includes the topics of waves, light, electricity and magnetism. This course is designed for students whose program requires technical physics, but who are not pre-engineering students or majors or minors in physics. Prerequisites: PHYS 1315 or PHYS 1335 with a grade of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Co-requisite(s):** PHYS 1125

**Course Attribute(s):** Life & Phys Sciences Core 030|Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**TCCN:** PHYS 1302

**PHYS 1335. General Physics I for Life Sciences Majors.**

This is the first course in a two-semester sequence which surveys the fundamental principles of physics. This focus of this first course is on the topics of mechanics, fluids, and heat. The course is designed for biology, pre-health, and life-science majors whose program requires technical physics. Credit for both PHYS 1335 and PHYS 1315 cannot be given. Prerequisite: [MATH 1315 or MATH 1317 or MATH 2321 or MATH 2417 or MATH 2471 with a grade of "C" or better] or [ACT Mathematics score of 24 or better] or [SAT Mathematics score of 520 or better] or [SAT Math section score of 550 or better] or [AAF score of 263 - 300]. Corequisite: PHYS 1115 with a grade of "D" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Life & Phys Sciences Core 030

**Grade Mode:** Standard Letter

**PHYS 1340. Astronomy: Solar System.**

A study of the solar system. Topics included are a study of the sun, the planets and their satellites, the comets, and other components of the solar system. Some aspects of telescopes and ancient astronomy will be included also.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Life & Phys Sciences Core 030|Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**TCCN:** ASTR 1304

**PHYS 1345. General Physics II for Life Science Majors.**

This is the second course in a two-semester sequence which surveys the fundamental principles of physics. The focus of this second course is on the topics of oscillations, light, and electrical phenomena. This course is designed for biology, pre-health, and life-science majors whose program requires technical physics. Prerequisite: PHYS 1315 or PHYS 1335 with a grade of "C" or better. Corequisite: PHYS 1125 with a grade of "D" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Life & Phys Sciences Core 030

**Grade Mode:** Standard Letter

**PHYS 1350. Astronomy: Stars and Galaxies.**

A study of the universe beyond the solar system. Topics included are a study of the stars and star clusters, nebulae, galaxies, and an introduction to some aspects of cosmology.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Life & Phys Sciences Core 030|Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**TCCN:** ASTR 1303

**PHYS 1365. Physics for Educators.**

This studio-style course introduces physics concepts through active exploration and discussion of physical phenomena. Course content includes developing concepts of force and motion, light, sound, waves, electricity, magnetism, energy, and conservation laws. Focus is on how physics helps make sense of everyday experience, and on the learning and teaching of children in grades K-8.

**3 Credit Hours. 4 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Life & Phys Sciences Core 030

**Grade Mode:** Standard Letter

**TCCN:** PHYS 1310

**PHYS 1430. Mechanics.**

This course covers the principles of classical mechanics through problem solving and laboratory investigations. PHYS 1430, PHYS 2425, and PHYS 2435 are designed for students majoring and minoring in physics and/or other disciplines within the college of science and engineering. Credit for both (PHYS 1315 and PHYS 1115) and PHYS 1430 cannot be given. Corequisite: MATH 2471 with a grade of "C" or better.

**4 Credit Hours. 3 Lecture Contact Hours. 3 Lab Contact Hours.**

**Course Attribute(s):** Life & Phys Sciences Core 030|Dif Tui- Science & Engineering|Lab Required

**Grade Mode:** Standard Letter

**TCCN:** PHYS 2425

**PHYS 2150. Professional Development for Beginning Physicists.**

This course introduces to physics majors career options and opportunities for internships, scholarships, and research internal and external to the university. The course also develops essential practical skills for job seekers. Prerequisite: PHYS 2425 and PHYS 2435 both with grades of "D" or better.

**1 Credit Hour. 1 Lecture Contact Hour. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 2230. Introduction to Computational Modeling for Physics.**

This course is an introduction to computational concepts and tools that physicists use for data analysis, simulation and modeling, and visualization in research and dissemination. Python and its various libraries are emphasized. Prerequisite: PHYS 1430 with a grade of "D" or better. Corequisite: PHYS 2425 or PHYS 2435 either with a grade of "C" or better.

**2 Credit Hours. 0 Lecture Contact Hours. 3 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 2425. Electricity and Magnetism.**

This course is a calculus-based introduction to electricity and magnetism. Prerequisites: PHYS 1430 and [MATH 2472 or MATH 2473] both with grades of "C" or better.

**4 Credit Hours. 3 Lecture Contact Hours. 3 Lab Contact Hours.**

**Course Attribute(s):** Life & Phys Sciences Core 030|Component Area Core 090|Life & Phys Sciences CAO 093|Dif Tui- Science & Engineering|Lab Required

**Grade Mode:** Standard Letter

**TCCN:** PHYS 2426

**PHYS 2435. Waves and Heat.**

This course is a study of the fields of wave motion, sound, light, and heat at a beginning level for physics majors and minors. Prerequisites: MATH 2471 and PHYS 1430 both with grades of "C" or better. Corequisite: MATH 2472 with a grade of "C" or better.

**4 Credit Hours. 3 Lecture Contact Hours. 3 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering|Lab Required

**Grade Mode:** Standard Letter

**TCCN:** PHYS 2427

**PHYS 3210. Physics Cognition and Pedagogy.**

This course is an introduction to physics-specific pedagogy and the methods and results of physics education research (PER). Students will investigate relevant literature in PER and cognitive science, engage in discussions about physics teaching and learning, and reflect on their own teaching practice in the role of Physics Learning Assistants. (WI).

**2 Credit Hours. 2 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering|Writing Intensive

**Grade Mode:** Standard Letter

**PHYS 3301. Musical Acoustics.**

A survey of the physics of sound and acoustic measurement. Special emphasis will be placed on sound production, propagation, and perception as applied to music.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 3311. Mechanics I.**

This course discusses the fundamentals of classical mechanics focusing on the physical description of the behavior of single and multiple particle systems. Topics included are advanced problem solving strategies for systems with position and velocity dependent forces, simple harmonic oscillators, and non-inertial reference frames. Prerequisite: PHYS 2435 with a grade of "C" or better. Corequisite: PHYS 3320 with a grade of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 3312. Modern Physics.**

This course is an introduction to the foundations of modern physics, including the following topics: relativistic mechanics, foundational experiments in the development of quantum mechanics, light and energy, wave nature of particles, and nuclear physics. Prerequisite: PHYS 2435 with a grade of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 3313. Astrophysics.**

This course surveys a variety of issues in astrophysics through problem solving, quantitative measurements, and theoretical reasoning. Topics include celestial mechanics, stellar dynamics and evolution, galaxy evolution, and cosmology. Corequisite: PHYS 3312 with a grade of "D" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 3315. Thermodynamics.**

This course is a fundamental study of thermodynamics and statistical mechanics. Prerequisite: MATH 3323 and [PHYS 2435 or (PHYS 1125 and PHYS 1325) or (ENGR 2300 and PHYS 2425)] all with grades of "D" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 3318. Galactic and Extragalactic Astrophysics.**

A survey of the physical properties, dynamics, and distribution of galaxies. Topics include the contents, origin, and evolution of the Milky Way and other galaxies; the large-scale distribution of galaxies in groups, clusters and superclusters; interactions between galaxies; dark matter; active galaxies and supermassive black holes; high redshift Universe. Prerequisite: PHYS 3313 with a grade of "D" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Grade Mode:** Standard Letter

**PHYS 3320. Introduction to Mathematical Physics.**

This course is an introduction to the mathematical methods of theoretical physics with emphasis on development of mathematical tools used in upper division core physics courses. Students will also develop their ability to communicate mathematical ideas in the context of physics. Prerequisite: [MATH 2393 or MATH 3373] and PHYS 2425 both with grades of "C" or better. Corequisite: MATH 3323 with a grade of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 3411. Advanced Physics Laboratory.**

This course is an introduction to experimental modern physics, with emphasis on the design and assembly of physics apparatus and the development of practical skills for controlling and automating data collection. (WI) Prerequisites: PHYS 2425 with a grade of "C" or better. Corequisites: PHYS 2435 with a grade of "C" or better.

**4 Credit Hours. 2 Lecture Contact Hours. 6 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering|Lab Required|Writing Intensive

**Grade Mode:** Standard Letter

**PHYS 3416. Applied Electronics.**

This Laboratory/lecture course is an introduction to electronic test bench methods for the construction, operation and analysis of important DC/AC circuits utilizing resistors, capacitors, diodes, BJTs, FETs, and OpAmps. The behavior of the circuits will be modeled in SPICE. Elementary semiconductor device physics and microfabrication methods will be discussed. (WI) Prerequisites: PHYS 2425 and PHYS 2435 both with grades of "C" or better.

**4 Credit Hours. 3 Lecture Contact Hours. 4 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering|Writing Intensive

**Grade Mode:** Standard Letter

**PHYS 3417. Optics.**

This course is a one-semester survey of geometrical and physical optics accompanied by laboratory experience. Topics covered include electromagnetic waves and their propagation, geometrical optics, polarization, interference, diffraction, Fourier optics, and holography. (WI) Prerequisites: PHYS 2425 and PHYS 2435 both with grades of "C" or better.

**4 Credit Hours. 3 Lecture Contact Hours. 3 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering|Writing Intensive

**Grade Mode:** Standard Letter

**PHYS 3418. Methods in Observational Astrophysics.**

This course is an introduction to methods and instrumentation used in observational astrophysics. Topics include image processing, data acquisition and analysis, and detectors for data across the electromagnetic spectrum. Prerequisite: PHYS 2425 and PHYS 2435 both with grades "C" or better.

**4 Credit Hours. 3 Lecture Contact Hours. 3 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering|Writing Intensive

**Grade Mode:** Standard Letter

**PHYS 4121. Undergraduate Research.**

This course represents a student's research project in physics to be carried out under the supervision of a faculty member. The student must contact a faculty member in advance to arrange the topic and specific course objectives. This course may be repeated for credit. Prerequisite: Instructor approval.

**1 Credit Hour. 0 Lecture Contact Hours. 3 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 4150A. Physics Cognition and Pedagogy Lab.**

In this lab course, students will apply principles introduced in PHYS 3210, which include observation of student interactions, reflection on the process of learning and the use of evidence based reasoning, metacognition, and facilitation, of discourse around difficult concepts. Prerequisite: PHYS 1430 with grade of "C" or better or instructor approval. Corequisite: PHYS 3210 with a grade of "D" or better.

**1 Credit Hour. 0 Lecture Contact Hours. 4 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Dif Tui- Science & Engineering|Topics

**Grade Mode:** Standard Letter

**PHYS 4150B. Computational Modeling Lab: Mechanics.**

This lab provides experience in computational modeling of problems in classical mechanics. Students design and code computer programs to simulate physical dynamics and analyze data. Corequisite: PHYS 3311 with a grade of "D" or better.

**1 Credit Hour. 0 Lecture Contact Hours. 3 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Dif Tui- Science & Engineering|Topics

**Grade Mode:** Standard Letter

**PHYS 4221. Undergraduate Research.**

This course represents a student's research project in physics to be carried out under the supervision of a faculty member. The student must contact a faculty member in advance to arrange the topic and specific course objectives. This course may be repeated for credit. Prerequisite: Instructor approval.

**2 Credit Hours. 0 Lecture Contact Hours. 6 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 4305. Statistical Physics.**

Statistical physics is the study of energy flow and energy distributions within systems in equilibrium. Students will explore a range of phenomena including black-body radiation, diffusion, phase transitions, and magnetism. Emphasis will be placed on topics of entropy, probability, free energy, Boltzmann distributions, and the atomic behavior of these systems. Prerequisite: MATH 3323 and PHYS 3312 and PHYS 3320 all with grades of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 4310. Electromagnetic Field Theory I.**

An introduction to the electromagnetic field theory of classical physics for static fields. Topics included will be the electrostatic field, polarization and dielectrics, electrostatic energy, magnetic field of steady currents, magneto static energy, and magnetic properties of matter. Prerequisite: [MATH 2393 or MATH 3373] and MATH 3323 and PHYS 3320 all with grades of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 4311. Condensed Matter Physics.**

Application of physics principles to solid materials. Topics include crystal structure and the reciprocal lattice, including x-ray diffraction, crystal binding and elastic properties, lattice vibrations, energy bands, semiconductors and metals. Prerequisite: PHYS 3312 and PHYS 3320 both with grades of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 4312. Quantum Mechanics I.**

This course introduces students to quantum mechanics. Topics include mathematical foundations, fundamental postulates, time development, and one dimensional problems. Prerequisite: PHYS 3312 PHYS 3320 both with grades of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 4315. Electromagnetic Field Theory II.**

An introduction to the electromagnetic field theory of classical physics for time varying fields. Topics included will be electromagnetic induction, time varying electric and magnetic fields, Maxwell's equations, electromagnetic energy, electromagnetic waves and radiation, and a brief introduction to some specialized topics. Prerequisite: PHYS 4310 with a grade of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 4320. Selected Study in Physics.**

Topics are chosen in theoretical and experimental areas of current interest in physics with specific topic to be discussed agreed upon prior to registration. May be repeated once with different emphasis and professor for additional credit. Prerequisite: Instructor approval.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 4321. Undergraduate Research.**

A research project in physics to be carried out under the supervision of a faculty member by upper division physics majors. Student must contact a faculty member in advance to arrange topic and specific course objective. Course may be repeated only as an elective towards the BS or BA in physics. Prerequisite: Instructor approval.

**3 Credit Hours. 0 Lecture Contact Hours. 9 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Dif Tui- Science & Engineering

**Grade Mode:** Standard Letter

**PHYS 4350B. Relativity.**

This course includes a review of Special Relativity, an introduction to the mathematics of tensor calculus and differential geometry, and such topics from General Relativity as the Schwarzschild solution and black holes, tests of General Relativity, cosmological models, and applications of relativity in the Global Positioning System (GPS). Prerequisite: PHYS 2425 and PHYS 2435 both with grades of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Dif Tui- Science & Engineering|Topics

**Grade Mode:** Standard Letter

**PHYS 4350D. Biophysics.**

This course applies the principles of physics to the study of living organisms. An emphasis will be placed on the topics of structure, fluids, diffusion, entropy, stochastic processes, and probabilities, and on scientific modes of thinking including modeling, estimation, and data analysis. Prerequisite: PHYS 2425 and PHYS 2435 both with grades of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Dif Tui- Science & Engineering|Topics

**Grade Mode:** Standard Letter

**PHYS 4350E. Musical Acoustics for Science and Engineering Majors.**

This course is a calculus-based approach to how and why each musical instrument and physical space has its own unique sonic character. Topics include wave phenomena in different materials and spatial configurations, signal processing and analysis, and computerized synthesis of musical sounds based on the laws of physics. Credit cannot be granted for both PHYS 4350E and PHYS 3301. Prerequisites: PHYS 2425 and PHYS 2435 both with grades of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Topics

**Grade Mode:** Standard Letter

**PHYS 4350F. Astronomical Spectroscopy.**

A lecture course introducing students to spectroscopy in astronomy, with particular emphasis on molecular spectroscopy. The course will cover a broad range of aspects including the development of spectroscopy in astronomy, the theory of atomic and molecular spectra, spectra in different astrophysical environments, instrumentation and data reduction.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Topics

**Grade Mode:** Standard Letter

**PHYS 4350G. Nuclear and Particle Physics.**

This course covers the theoretical, phenomenological, and experimental foundations of nuclear and particle physics including the fundamental forces, particles, and composites. An emphasis will be on the fundamental structure of nucleus (nuclear masses and nuclear sizes), nuclear interactions (alpha, beta, and gamma radiation), Fission, Fusion, beyond nuclear physics (quarks and leptons as basic constituents of matter), brief introduction to the Standard model: electroweak interactions, Higgs boson, QCD and basic nuclear Astrophysics (nucleosynthesis of stellar particles). Prerequisite: PHYS 2425 and PHYS 3212 both with grades of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Exclude from 3-peat Processing|Topics

**Grade Mode:** Standard Letter

**PHYS 4360. Physics Cognition and Pedagogy II.**

This course addresses historical, philosophical, and cognitive perspectives on the learning, teaching, and discovery of physics, including results from contemporary research on learning. It is recommended for students pursuing teacher certification. Prerequisite: PHYS 3210 with a grade of "C" or better.

**3 Credit Hours. 3 Lecture Contact Hours. 0 Lab Contact Hours.**

**Course Attribute(s):** Dif Tui- Science & Engineering|Writing Intensive

**Grade Mode:** Standard Letter