

# PHYSICS

Physics is the science of matter, energy and their interactions. Physics majors learn the fundamental laws governing the natural world, and in so doing develop critical skills of observation and quantitative analysis in both experimental and theoretical settings. Because those skills are increasingly valued in diverse fields in today's technological society, persons trained in physics are found not only in science, but also in fields where analytical skills are vital to success, such as finance, medicine, law and engineering.

The Department of Physics offers three different degree options for students. First, the "BS in Physics" degree is designed for students who seek a broad, comprehensive study of the set of traditional as well as contemporary topics which together comprise the subject of physics, and who ultimately may be interested in obtaining master's and/or doctoral degrees and becoming professional physicists or astronomers. In contrast, the "BS in Applied Physics" degree concentration has been developed for students who wish to combine studies in physics with studies in other areas such as engineering, biology and microbiology (including Pre-Med requirements), geology, business, computer science, mathematics, or perhaps in preparation for graduate degrees in those areas. Our "BS in Physics, Secondary Teacher Certification" degree is aimed to provide students with the basic foundation in physics needed to prepare for a professional career in secondary education. Students who complete this degree are fully certified to teach Physics in the state of Oklahoma upon graduation. The Department also encourages students to consider interdisciplinary study opportunities afforded from a double major or minor with physics. The detailed requirements for all degree programs of the Physics Department can be obtained from the department office or its website: <https://physics.okstate.edu/>.

During their first two years, physics majors learn the laws of mechanics (forces and motion) and electromagnetism which epitomize the work of Newton and Maxwell, among others. At the same time, students develop their mathematical skills through courses in calculus and differential equations.

During their last two years, physics majors delve into advanced topics including the quantum and relativistic physics of Schroedinger, Einstein and their colleagues. Courses in laboratory and computational methods further develop experimental abilities. Students are also encouraged to work in the department's research labs or astronomical observatory. Students pursuing the BS in physics take additional physics courses and do a senior project. Students seeking the BS in applied physics replace the additional physics courses with upper-division courses in their chosen areas.

Please contact Sheri Orr, Sr. Academic Advisor ([sheri.m.orr@okstate.edu](mailto:sheri.m.orr@okstate.edu)), to learn more!

## Courses

### PHYS 1001 Frontiers of Physics

**Prerequisites:** Freshmen and sophomore Physics Majors only or consent of instructor.

**Description:** Student and faculty discussions of current research topics in physics. Includes laboratory tours and research presentation by faculty. Graded on pass-fail basis.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Physics

### PHYS 1014 Descriptive Physics (N)

**Description:** A survey course presenting the basic concepts and principles of physics with a minimum of mathematics. Motion, waves, temperature, electricity, magnetism, optics, atomic structure, and nuclear energy.

**Credit hours:** 4

**Contact hours:** Lecture: 4 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Physics

**General Education and other Course Attributes:** Natural Sciences

### PHYS 1114 College Physics I (LN)

**Prerequisites:** MATH 1513 or higher with a "C" or better, or an acceptable placement score (see [placement.okstate.edu](http://placement.okstate.edu)).

**Description:** Algebra-based introductory course covering physics appropriate for applied and life sciences or pre-professional majors. Topics covered - Newtonian mechanics, fluids, thermodynamics, waves, and sound.

**Credit hours:** 4

**Contact hours:** Lecture: 2 Lab: 2 Contact: 5 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Lab, Lecture, Combined lecture lab & disc

**Department/School:** Physics

**General Education and other Course Attributes:** Scientific Investigation, Natural Sciences

### PHYS 1214 College Physics II (LN)

**Prerequisites:** PHYS 1114 or PHYS 2014 with a "C" or better or acceptable AP credit.

**Description:** A continuation of College Physics I for students in the applied-sciences, life-sciences, and pre-professional majors. Covers electricity, magnetism, optics, quantum physics, atomic and nuclear structure.

**Credit hours:** 4

**Contact hours:** Lecture: 2 Lab: 2 Contact: 5 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Lab, Lecture, Combined lecture lab & disc

**Department/School:** Physics

**General Education and other Course Attributes:** Scientific Investigation, Natural Sciences

**PHYS 2014 University Physics I (LN)**

**Prerequisites:** A minimum grade of "C" in MATH 2103 or MATH 2123 or MATH 2144 or acceptable AP credit.

**Description:** Calculus-based introductory course covering mechanics, waves, heat, and thermodynamics for physical science, math, and engineering majors.

**Credit hours:** 4

**Contact hours:** Lecture: 2 Lab: 2 Contact: 5 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Lab, Lecture, Combined lecture lab & disc

**Department/School:** Physics

**General Education and other Course Attributes:** Scientific Investigation, Natural Sciences

**PHYS 2020 Special Topics in Physics (L)**

**Description:** Laboratory exercises for College Physics I, College Physics II, University Physics I or University Physics II. Offered for variable credit, 1-3 credit hours, maximum of 6 credit hours.

**Credit hours:** 1-3

**Contact hours:** Lab: 2-6 Contact: 2-6

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Physics

**General Education and other Course Attributes:** Scientific Investigation

**PHYS 2114 University Physics II (LN)**

**Prerequisites:** PHYS 2014 with a "C" or better or acceptable AP credit.

**Description:** A continuation of University Physics I covering electricity, magnetism, and optics for physical sciences, math, and engineering majors.

**Credit hours:** 4

**Contact hours:** Lecture: 2 Lab: 2 Contact: 5 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Lab, Lecture, Combined lecture lab & disc

**Department/School:** Physics

**General Education and other Course Attributes:** Scientific Investigation, Natural Sciences

**PHYS 2203 University Physics III**

**Prerequisites:** PHYS 2114 with a grade of "C" or better or acceptable AP credit.

**Description:** A continuation of PHYS 2114 for all Physics majors. Topics include: heat, special relativity, and atomic and nuclear physics.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Physics

**PHYS 2663 Physics in Medicine (N)**

**Description:** Course will introduce important technologies widely used in modern medicine and the basic physics and physiology that underlies them. Examples include EKG machines, ultrasound imaging, laser surgery, x-ray, CT, PET, and MRI. Field trips required.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Physics

**General Education and other Course Attributes:** Natural Sciences

**PHYS 2890 Honors Experience in Physics**

**Prerequisites:** Honors Program participation and concurrent enrollment in designated course(s).

**Description:** A supplemental Honors experience in Physics to partner concurrently with designated lower division PHYS course(s). This course adds a different intellectual dimension to designated course(s). Offered for fixed credit, 1 credit hour, maximum of 6 credit hours.

**Credit hours:** 1

**Contact hours:** Lecture: 1 Contact: 1

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Physics

**General Education and other Course Attributes:** Honors Credit

**PHYS 3013 Mechanics I**

**Prerequisites:** PHYS 2114 or equivalent, and MATH 2233 or concurrent enrollment.

**Description:** Mechanics of particles, systems of particles and rigid bodies.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Physics

**PHYS 3113 Thermal Physics**

**Prerequisites:** PHYS 2203 and MATH 2163 or concurrent enrollment.

**Description:** Thermometry, heat transfer, elementary theory of specific heat and the three laws of thermodynamics.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Physics

**PHYS 3213 Optics**

**Prerequisites:** PHYS 2114 and PHYS 3513, or consent of the instructor.

**Description:** Geometrical optics; interference, diffraction, dispersion, absorption, and polarization of light.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Physics

**PHYS 3313 Introduction to Semiconductor Device Physics**

**Prerequisites:** PHYS 2114 or equivalent.

**Description:** An introduction to crystal structure, the quantum theory of solids, the physics of semiconductor materials and the pn junction, with an emphasis on applications to semiconductor devices. Same course as ECEN 3903.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Physics

**PHYS 3323 Modern Laboratory Methods I****Prerequisites:** PHYS 2014, PHYS 2114.**Description:** Introduction to electric and electronic measurements and computer applications in experimental control, data collection and laboratory computation. Experiments on test instruments, integrated electronics, signal processing, computer interfacing, and data acquisition. Previously offered as PHYS 3322.**Credit hours:** 3**Contact hours:** Lab: 6 Contact: 6**Levels:** Undergraduate**Schedule types:** Lab**Department/School:** Physics**PHYS 3513 Mathematical Physics****Prerequisites:** PHYS 2114 and MATH 2163.**Description:** Physical applications of vectors, vector calculus and differential equations. Fourier analysis. Orbit geometry, coordinate systems and transformation of coordinates. Matrices and determinants.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 3553 Foundations of Cancer****Prerequisites:** Minimum grade of "C" in CHEM 1225 or CHEM 1414 or CHEM 1515.**Description:** Course covers six themes: causes of cancer, cancer genetics, cancer diagnosis, cancer treatment, immuno-oncology, and cancer prevention. Course will illustrate both setbacks and victories in applying the scientific method to biological processes and the evidence for and assumptions made in these approaches will be discussed. Designed for future: medical doctors, cancer researchers, medical engineers, and to cancer patients or relatives. Same course as MICR 3553. May not be used for degree credit with PHYS 5553 and MICR 5553.**Credit hours:** 3**Contact hours:** Lecture: 2 Contact: 3 Other: 1**Levels:** Undergraduate**Schedule types:** Discussion, Combined lecture & discussion, Lecture**Department/School:** Physics**PHYS 3623 Modern Laboratory Methods II****Prerequisites:** PHYS 2014, PHYS 2114.**Description:** Introduction to the operating principles and applications of modern physical methods used in research. Laboratory experiments with lasers, wave propagation, thermometry, radiation detection, optical interferometry, and spectroscopy.**Credit hours:** 3**Contact hours:** Lab: 6 Contact: 6**Levels:** Undergraduate**Schedule types:** Lab**Department/School:** Physics**PHYS 3713 Modern Physics****Prerequisites:** PHYS 2203 with a "C" or better.**Description:** This is the first course in the undergraduate quantum physics sequence. It covers the basic features of quantum mechanics as they relate to atomic systems, nuclear matter, photons, and electrons.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 4003 Computer Simulation Methods in Physics****Prerequisites:** PHYS 3013, PHYS 3113, PHYS 3313 or consent of instructor.**Description:** Introduction to computer simulation methods used in the physical sciences. Linear systems, nonlinear systems, molecular dynamics, Monte Carlo methods, cellular automata, simple quantum systems. Some knowledge of either C, FORTRAN, Pascal, or BASIC required. Previously offered as PHYS 3993.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 4010 Special Problems****Prerequisites:** Consent of instructor.**Description:** Individual laboratory work of an advanced nature. Offered for variable credit, 1-3 credit hours, maximum of 9 credit hours.**Credit hours:** 1-3**Contact hours:** Contact: 1-3 Other: 1-3**Levels:** Undergraduate**Schedule types:** Independent Study**Department/School:** Physics**PHYS 4113 Electricity and Magnetism****Prerequisites:** PHYS 2114 and MATH 2233, or their equivalents.**Description:** Electrostatic fields, magnetic fields of steady currents, induced EMFs, Maxwell's equations and introduction to electromagnetic wave theory. Vector analysis used.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 4213 Introduction to Nuclear and Particle Physics****Prerequisites:** PHYS 2114 and PHYS 3713 or consent of instructor.**Description:** Survey of phenomenological aspects of nuclear and particle physics, photon and charged particle interactions with matter, particle detectors, particle accelerators, electromagnetic, strong and weak interactions, models of the nucleus, quark model of mesons and baryons, elementary particles, and symmetries in the Standard Model.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 4223 Introduction to General Relativity****Prerequisites:** Minimum grade of "C" in both PHYS 2203 and PHYS 3513 or consent of instructor.**Description:** An introduction to Einstein's theory of relativity, including the metric description of spacetime, relativistic kinematics in flat spacetime, coordinate transformations, gravity as curved spacetime, and black holes.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics

**PHYS 4263 Introduction to Solid State Physics****Prerequisites:** PHYS 3013, PHYS 3713 or consent of instructor.**Description:** Structure, specific heat, dielectric properties, lattice vibrations, free electron theory, band structure, and superconductivity of solids.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 4313 Molecular Biophysics****Prerequisites:** PHYS 1214 or PHYS 2114.**Description:** Survey of experimental and computational methods for determining the structure and function of biomolecular assemblies such as proteins and membranes. Techniques to be discussed include: X-ray diffraction, nuclear and electron spin resonance, optical spectroscopy, photobiophysics, kinetic modeling, molecular dynamics, Monte Carlo and homology modeling.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 4413 Modern Physics II****Prerequisites:** PHYS 3013 and PHYS 3713.**Description:** Atomic and X-ray spectra; one-dimensional Schroedinger equation; nuclear structure; introduction to statistical mechanics and elementary quantum statistics.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 4423 Mechanics II****Prerequisites:** PHYS 3013.**Description:** Lagrangian and Hamiltonian dynamics, calculus of variations, constrained systems, coupled oscillators, continuous systems and waves.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 4513 Introductory Quantum Mechanics****Prerequisites:** PHYS 3713.**Description:** Uncertainty principle, setting up Schroedinger equation (time dependent as well as time independent) and solving it for linear oscillator, hydrogen atom, periodic, and other potentials.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 4663 Radioactivity and Nuclear Physics****Prerequisites:** PHYS 3713 or consent of instructor.**Description:** Natural and artificial radioactivity, decay laws; absorption, detection and measurement of radiations; nuclear transformations.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 4712 Senior Project****Description:** Advanced individual experimental projects. Project proposal, formal laboratory report, and oral presentation are required.**Credit hours:** 2**Contact hours:** Contact: 2 Other: 2**Levels:** Undergraduate**Schedule types:** Independent Study**Department/School:** Physics**PHYS 4813 Electromagnetic Radiation****Prerequisites:** PHYS 4113 with minimum grade of "C."**Description:** Electromagnetic wave theory, reflection and refraction of electromagnetic waves; resonant cavities, wave guides, fiber propagation of electromagnetic waves; radiation sources; relativistic description of electromagnetic fields.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 4993 Senior Honors Thesis****Prerequisites:** Departmental invitation, senior standing, Honors Program participation.**Description:** A guided reading and research program ending with an honors thesis under the direction of a faculty member, with second faculty reader and oral examination. Required for graduation with departmental honors in physics.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Physics**General Education and other Course Attributes:** Honors Credit**PHYS 5000 Master's Thesis Research or Report****Prerequisites:** Consent of major professor.**Description:** Thesis research or report for master's degree. Offered for variable credit, 1-9 credit hours, maximum of 9 credit hours.**Credit hours:** 1-9**Contact hours:** Contact: 1-9 Other: 1-9**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Physics**PHYS 5110 Seminar****Prerequisites:** Graduate standing in physics.**Description:** Special topics in physics. Offered for variable credit, 1-5 credit hours, maximum of 20 credit hours.**Credit hours:** 1-5**Contact hours:** Contact: 1-5 Other: 1-5**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Physics

**PHYS 5113 Statistical Thermodynamics and Kinetic Theory****Prerequisites:** PHYS 3113.**Description:** Fundamental concepts of thermodynamics: first, second and third laws; thermodynamic potentials. Statistical physics: Maxwell-Boltzman, Fermi-Dirac, Bose-Einstein distribution functions. Kinetic theory: transport phenomena, Boltzman H Theorem, the approach to thermodynamic equilibrium.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5123 Geometrical Optics****Prerequisites:** PHYS 3213 or consent of instructor.**Description:** Foundations of geometrical optics, geometrical theory of optical imaging, geometrical theory of aberrations, image forming instruments. Same course as ECEN 5803.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5133 Laser Spectroscopy****Prerequisites:** PHYS 5163.**Description:** Principles of different types of laser spectroscopy based on fluorescence, absorption, saturated absorption, absorption in a cavity: Infrared, Raman, light scattering, four wave mixing, CARS, phase conjugation, two photon absorption, double resonance, and multiphoton ionization.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5163 Lasers****Prerequisites:** PHYS 4813 or equivalent.**Description:** Semi-classical description of absorption and emission of light by matter; effects of cavities and optical elements; theory of lasers' gas, liquid, solid state and semiconductor. Electro-optics. Techniques of mode-locking, Q-switching, phase conjugation, Fourier transform optics. An introduction to non-linear optics.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5213 Statistical Mechanics****Prerequisites:** PHYS 5113 and PHYS 5613 or consent of instructor.**Description:** Classical and quantum mechanical distribution functions for independent particles; interacting classical and quantum systems, superfluidity, phase transitions and critical phenomena, approximation methods.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5220 Physics Topics for Teachers****Prerequisites:** Teaching experience or consent of instructor.**Description:** Special topics for elementary and secondary science teachers to improve their subject matter competence. Content varies, depending on the needs of specific groups of teachers. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Physics**PHYS 5263 Particle Physics****Prerequisites:** PHYS 5613 or consent of instructor.**Description:** Phenomenology of elementary particles: quark model, electromagnetic, weak, and strong interactions of quarks, leptons, and gauge bosons, Feynman diagram techniques, parton model, gauge symmetries, spontaneous symmetry breaking, Standard model, experimental tests.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5303 Physical Optics****Prerequisites:** PHYS 3213 or consent of instructor.**Description:** Multiple beam interference, diffractions, imaging, near field optical probes of matter, surface plasmons, light scattering from random media, optical coherence tomography - biomedical applications, negative materials, perfect lenses and super resolution. Same course as ECEN 5823.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5313 Electromagnetic Theory****Prerequisites:** PHYS 5453.**Description:** Electric and magnetic fields in free space and in matter. Boundary value problems, Green's functions, stress tensors, multipole expansions, thermodynamics; electromagnetic waves.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5350 Special Problems****Prerequisites:** Graduate standing in physics.**Description:** Special problems of experimental or theoretical nature. Largely individual work with written report required. Offered for variable credit, 1-3 credit hours, maximum of 12 credit hours.**Credit hours:** 1-3**Contact hours:** Contact: 1-3 Other: 1-3**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Physics

**PHYS 5413 Classical Mechanics****Prerequisites:** PHYS 4423 or consent of instructor.**Description:** Generalized coordinates and advanced dynamics; coupled systems, wave motion; theory of elasticity.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5453 Mathematical Methods for Physicists****Prerequisites:** PHYS 3513.**Description:** Introduction to mathematical techniques used in analyzing problems in physics.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5523 Radiation Detection and Measurement****Prerequisites:** PHYS 3713 and PHYS 4213.**Description:** Overview of radiation detection and measurement. Instrumentation, statistics of radiation measurements, review of atomic and nuclear physics, review of radiation interaction with matter, nuclear electronics, gas-filled and scintillation detectors, semiconductor detectors, radiation counting and spectroscopy.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5533 Dosimetry and Radiation Protection****Prerequisites:** PHYS 4663 and PHYS 5523 or consent of instructor.**Description:** Radiation dosimetry quantities, effects of ionizing radiation on the human body, basic radiation protection concepts, x-ray and  $\gamma$ -ray interaction and attenuation with matter, charged particle and neutron interaction with matter, charged particle equilibria, Bragg-Gray Cavity theory, quantifying dose from radionuclide sources, survey of dosimetric instrumentation, dosimetry with ionization chambers, integrating dosimeters and personal dosimetry.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5553 Foundations of Cancer****Prerequisites:** Minimum grade of "C" in (or equivalent) or MICR 3033 (or equivalent) or consent of instructor.**Description:** Course covers six themes: causes of cancer, cancer genetics, cancer diagnosis, cancer treatment, immuno-oncology, and cancer prevention. Course will illustrate both setbacks and victories in applying the scientific method to biological processes and the evidence for and assumptions made in these approaches will be discussed. Designed for future: medical doctors, cancer researchers, medical engineers, and to cancer patients or relatives. Same course as MICR 5553. May not be used for degree credit with PHYS 3553 or MICR 5553.**Credit hours:** 3**Contact hours:** Lecture: 2 Contact: 3 Other: 1**Levels:** Graduate**Schedule types:** Discussion, Combined lecture & discussion, Lecture**Department/School:** Physics**PHYS 5563 Radioactivity and Nuclear Physics Laboratory****Prerequisites:** PHYS 4663 and PHYS 5523 or consent of instructor.**Description:** The primary objective of this course is to provide students with hands-on experience in a range of experimental techniques and with a variety of instrumentation routinely used in radiation detection and dosimetry, nuclear and particle physics, and in radiotherapy and medical imaging. The course content can be thought of as being of two types: 1) general experimental methods in physics and 2) methods of radiation detection and measurement.**Credit hours:** 3**Contact hours:** Lecture: 1 Lab: 4 Contact: 5**Levels:** Graduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Physics**PHYS 5573 Radiation Biophysics****Prerequisites:** PHYS 5533 or consent of instructor.**Description:** Introduction to radiation biophysics, structure of DNA and its relationship to carcinogenesis, stochastic nature of radiation interaction with matter, radiation chemistry, cell survival curves, radiation damage models, DNA damage response.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5593 Physics of Radiation Therapy****Prerequisites:** PHYS 5533 or consent of instructor.**Description:** Overview of radiation therapy, dosimetry in radiation therapy, megavoltage x-ray and electron therapy, manual treatment planning, computer-based treatment planning, brachytherapy, proton therapy.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5613 Quantum Mechanics I****Prerequisites:** PHYS 5453.**Description:** Postulates of quantum mechanics. Operators, commutation relations, eigenfunctions. Schrodinger, Heisenberg and interaction formalisms, angular momentum and central field problems; nondegenerate perturbation theory.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5663 Solid State Physics I****Prerequisites:** PHYS 4513.**Description:** Crystal structure, cohesive energy of ionic crystals and metals, specific heats, free electron theory of metals, band theory, Brillouin zones, insulators and alloys; magnetic properties, optical properties and thermal and electrical conductivity of solids.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics

**PHYS 5713 Solid State Physics II****Prerequisites:** PHYS 5663 or equivalent.**Description:** Symmetry, dielectric properties, ferroelectrics, magnetic properties, mechanical properties, and defects of solids.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5813 General Relativity****Prerequisites:** PHYS 5453 or consent of instructor.**Description:** Theory and applications of general relativity: the principle of equivalence, general coordinate invariance, tensors, affine connections, Einstein's field equations, classic tests, application to stellar dynamics, black holes, and cosmology.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 5960 Problems in Chemical Physics****Prerequisites:** Consent of instructor.**Description:** Intermolecular forces, interaction of radiation with matter in bulk form, dielectric properties of matter, polymer physics and quantum theory of biopolymers. Offered for variable credit, 3-6 credit hours, maximum of 6 credit hours.**Credit hours:** 3-6**Contact hours:** Contact: 3-6 Other: 3-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Physics**PHYS 6000 Doctoral Dissertation Research****Prerequisites:** Admission to candidacy and permission of major professor.**Description:** Offered for variable credit, 1-15 credit hours, maximum of 60 credit hours.**Credit hours:** 1-15**Contact hours:** Contact: 1-15 Other: 1-15**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Physics**PHYS 6010 Advanced Graduate Seminar****Prerequisites:** Consent of instructor.**Description:** Special topics of an advanced nature in physics. Offered for variable credit, 1-3 credit hours, maximum of 15 credit hours.**Credit hours:** 1-3**Contact hours:** Contact: 1-3 Other: 1-3**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Physics**PHYS 6113 Advanced Theory of Solids****Prerequisites:** PHYS 5663.**Description:** Many-body techniques, transport processes, band theoretical techniques, superconductivity, dynamics of electrons in a magnetic field, and alloys.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 6213 Group Theory for Physics****Prerequisites:** PHYS 5453.**Description:** Group theory and imperfections in crystals. Dislocation theory and color centers.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 6243 Semiconductors I****Prerequisites:** PHYS 5113, PHYS 5613, PHYS 5663.**Description:** The first part of a survey of the physics of semi-conductors. Bonding and structure, crystal growth, epitaxial growth, band theory, phonons, photons, defects, intrinsic and extrinsic statistics, trapping and recombination.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 6260 Special Topics in High Energy Physics****Prerequisites:** PHYS 5263 or consent of instructor.**Description:** Advanced topics of current interest in high-energy physics: collider physics, supersymmetry, unification, flavor physics, string phenomenology, extra dimensions. Offered for variable credit, 1-3 credit hours, maximum of 9 credit hours.**Credit hours:** 1-3**Contact hours:** Contact: 1-3 Other: 1-3**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Physics**PHYS 6313 Quantum Mechanics II****Prerequisites:** PHYS 5613.**Description:** Scattering theory, many-particle quantum mechanics and application to atomic and molecular systems; degenerate and time-dependent perturbation theory.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 6323 Quantum Field Theory****Prerequisites:** PHYS 6313 or consent of instructor.**Description:** Relativistic Quantum Mechanics: Klein-Gordon field, path integral formulation of Quantum Mechanics, Feynman diagrams, Quantum Electrodynamics, relativistic scattering radiative corrections, renormalization and critical exponents, non-Abelian gauge theories, spontaneous symmetry breaking.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics

**PHYS 6343 Semiconductors II****Prerequisites:** PHYS 6243.**Description:** The second part of the semiconductors sequence. Transport phenomena, junctions, devices, heterostructures, and optical properties.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 6413 Nonlinear Optics****Prerequisites:** PHYS 5163, PHYS 5313, and PHYS 5613.**Description:** The response of matter at high radiation powers; nonlinear susceptibilities. Wave propagation in nonlinear medium; three wave and four wave interactions; saturated absorption, optical switching and limiting; two photon and stimulated Raman processes; Self focusing; solitons.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 6423 Quantum Optics****Prerequisites:** PHYS 5163, PHYS 5613 or consent of instructor.**Description:** Quantization of Electromagnetic Fields, coherence, quantum entanglement, parametric down conversion, two photon interferometry, Bell's inequalities, quantum teleportation and cryptography, cavity QED.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 6513 Advanced Topics in Solid State Physics****Prerequisites:** PHYS 5663 or equivalent.**Description:** Interaction of radiation and matter, neutron scattering, phase transitions, magnetic resonance and cooperative phenomena.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 6613 Advanced Nuclear and Particle Physics****Prerequisites:** PHYS 5263, PHYS 6313; or consent of instructor.**Description:** Renormalization of quantum field theories, spontaneous symmetry breaking, Standard model, flavor physics, grand unification, super-symmetry.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 6713 Advanced Electromagnetic Radiation****Prerequisites:** Consent of instructor.**Description:** Radiation theory, wave guides, scattering and dispersion relations; relativity.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 6803 Photonics I: Advanced Optics****Prerequisites:** ECEN 3213 or ECEN 3813.**Description:** Advanced optics including spectral and time characteristics of detectors, characteristics of lasers, time, spectral and spatial parameters of laser emission, interferometric techniques, and nonlinear effects such as two-photon absorption and second and third harmonic generations. Ultrashort laser pulses. Same course as CHEM 6803 & ECEN 6803. Offered for fixed credit, 3 credit hours, maximum of 9 credit hours.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Physics**PHYS 6810 Photonics II: THz Photonics and THz-TDS****Prerequisites:** PHYS 6803.**Description:** THz photonics and THz time-domain spectroscopy (THz-TDS). Concepts and techniques of driving electronic circuitry with ultrashort laser pulses to generate and detect freely propagating pulses of THz electromagnetic radiation using several operational research systems. Same course as CHEM 6810 & ECEN 6810. Previously offered as PHYS 6811. Offered for fixed credit, 1 credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Physics**PHYS 6820 Photonics II: Spectroscopy II****Prerequisites:** PHYS 6803.**Description:** Operating principles and applications of laser spectroscopy of atoms, molecules, solids and complex fluids. Absorption, emission, photon correlation, coherence, time resolved Fourier transform. Raman spectroscopy and non-linear optical. Same course as CHEM 6820 & ECEN 6820. Offered for fixed credit, 1 credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Physics**PHYS 6830 Photonics II: Spectroscopy III****Prerequisites:** PHYS 6803.**Description:** Advanced spectroscopic instruments and methods used for investigation of semi-conductors and solid state material. Stimulated emission characterized both in wavelength and in time. Time-resolved fluorescence measurements. Multiphotonic excitations. Fast measuring techniques including subnanosecond detectors, picosecond streak cameras, and ultrafast four-wave mixing and correlation techniques. Time-dependent photoconductivity measurements. Same course as CHEM 6830 & ECEN 6830. Previously offered as PHYS 6831. Offered for fixed credit, 1 credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Physics



**PHYS 6840 Photonics III: Microscopy I****Prerequisites:** CHEM 3553 or consent of instructor.**Description:** The structure and imaging of solid surfaces. Basics of scanning probe microscopy (SPM). Contact and noncontact atomic force microscopy (AFM). Scanning tunneling microscopy (STM) in air. Same course as CHEM 6840 & ECEN 6840. Previously offered as PHYS 6841. Offered for fixed credit, 1 credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Physics**PHYS 6850 Photonics III: Microscopy II****Prerequisites:** PHYS 3553 or consent of instructor.**Description:** Advanced techniques of scanning probe microscopy (SPM). Magnetic force microscopy, Kelvin force microscopy, scanning, tunneling microscopy (STM) in vacuum. Characterization of materials with SPM. Nanolithography with SPM. Device manufacturing and analysis. Same course as CHEM 6850 & ECEN 6850. Previously offered as PHYS 6851. Offered for fixed credit, 1 credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Physics**PHYS 6860 Photonics III: Microscopy III and Image Processing****Prerequisites:** ECEN 5793.**Description:** Digital image processing, including projects. Image acquisition and display, image enhancement, geometric operations, linear and nonlinear filtering, image restoration, edge detection, image analysis, morphology, segmentation, recognition, and coding and compression. Same course as CHEM 6860 & ECEN 6860. Previously offered as PHYS 6861. Offered for fixed credit, 1 credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Physics**PHYS 6870 Photonics IV: Synthesis and Devices I****Prerequisites:** PHYS 6803 and PHYS 6840.**Description:** Preparation of functional nanostructures and related optical and electronic devices. Physical and chemical methods of thin film deposition. Engineering of prototypes of light emitting diodes, sensors, optical limiting coatings, lithographic patterns. Same course as CHEM 6870 & ECEN 6870. Previously offered as PHYS 6871. Offered for fixed credit, 1 credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Physics**PHYS 6880 Photonics IV: Semiconductor Devices, Testing and Characterization****Prerequisites:** PHYS 6803.**Description:** Test and characterization of semiconductor and optoelectronic devices. Hall effect, four point probe, CV and IV measurements, optical pump-probe, photoluminescence, and electro-optics sampling. Same course as CHEM 6880 & ECEN 6880. Previously offered as PHYS 6881. Offered for fixed credit, 1 credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Physics**PHYS 6890 Photonics IV: Semiconductor Synthesis and Devices III****Prerequisites:** PHYS 6803.**Description:** Processing, fabrication and characterization of semiconductor optoelectronic devices in class 100/10000 cleanrooms. Cleanroom operation including general procedure for material processing and device fabrication. Device processing using a variety of processing such as mask aligner, vacuum evaporators and rapid thermal annealer. Testing using optical and electrical testing apparatus such as I-V, C-V Hall, and optical spectral measurement systems. Same course as CHEM 6890 & ECEN 6890. Previously offered as PHYS 6891. Offered for fixed credit, 1 credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Physics

## Undergraduate Programs

- Physics, BS (<http://catalog.okstate.edu/arts-sciences/physics/bs/>)
- Physics: Applied Physics, BS (<http://catalog.okstate.edu/arts-sciences/physics/applied-physics-bs/>)
- Physics: Secondary Teacher Certification, BS (<http://catalog.okstate.edu/arts-sciences/physics/secondary-teacher-certification-bs/>)

## Graduate Programs

### Prerequisites

Thirty semester hours of physics beyond the elementary course work and mathematics courses through advanced calculus and differential equations are normally required.

## The Master of Science Degree

Students can choose between a thesis or non-thesis plan. For both plans, the required courses are the following:

Code	Title	Hours
PHYS 5113	Statistical Thermodynamics and Kinetic Theory	3
PHYS 5313	Electromagnetic Theory	3
PHYS 5413	Classical Mechanics	3
PHYS 5453	Mathematical Methods for Physicists	3
PHYS 5613	Quantum Mechanics I	3

The thesis plan requires the successful completion of 30 semester credit hours beyond the BS, which include the required courses; nine semester credit hours of electives in physics, mathematics or an allied field; and the submission of an acceptable thesis along with six credit hours of PHYS 5000 Master's Thesis Research or Report. The thesis is to be based on original and independent research, on a topic chosen in consultation with the student's advisor. The student must successfully defend the thesis in an oral examination. The non-thesis plan requires 32 semester credit hours beyond the BS degree, including the required courses; fifteen hours of electives (with up to nine credit hours of senior level courses); and two credit hours of library research (PHYS 5000 Master's Thesis Research or Report) on a topic chosen in consultation with the student's advisor. A completed written report based on the library research must be orally presented to the student's advisory committee. For both plans, the electives must be chosen in consultation with the student's advisory committee.

Also available at the MS level is an option in optics and photonics, in association with the School of Electrical and Computer Engineering. Students may pursue one of two plans, both of which require 24 credit hours of coursework with at least one course taken outside the student's specialization. Beyond this, the first plan (30 credit hours) requires an additional six hours of research and a successful defense of a thesis. The second plan (32 credit hours) requires an additional six hours of coursework and a two-credit-hour report.

## The Doctor of Philosophy Degree

The following physics courses are required:

Code	Title	Hours
PHYS 5113	Statistical Thermodynamics and Kinetic Theory	3
PHYS 5213	Statistical Mechanics	3
PHYS 5313	Electromagnetic Theory	3
PHYS 5413	Classical Mechanics	3
PHYS 5453	Mathematical Methods for Physicists	3
PHYS 5613	Quantum Mechanics I	3
PHYS 6313	Quantum Mechanics II	3

Three additional PHYS prefix courses at the 5000- or 6000-level, including at least one course not in the student's specialization, must be completed. Additional courses reflecting the candidate's specialization may be required by the advisory committee. Seventy-two (72) semester hours of credit beyond the bachelor's degree, or sixty semester hours of credit beyond the master's degree are required. A minimum of two-thirds of the graduate course credits must be in physics. No more than six credit hours of eligible physics coursework at the 4000-level can be counted toward graduate credit and no more than 12 total credit hours of eligible coursework in all subjects at the 3000- or 4000-level can be counted toward graduate credit. Courses taken at another institution will be evaluated by a faculty committee to determine whether they satisfy any requirements.

A Photonics PhD program shared with the Electrical and Computer Engineering Department is also available, with Physics as the home department. Details of the multidisciplinary photonics PhD program are found in the "Graduate College (<http://catalog.okstate.edu/graduate-college/>)" section of the Catalog.

The most important single requirement for the PhD in physics is the presentation of an acceptable dissertation which represents original

research work by the student and which demonstrates the student's ability to do independent study as well as to plan and carry out future research in his or her field. Full information on graduate programs in the Department of Physics is available from the Graduate Coordinator or from the department website at [physics.okstate.edu](https://physics.okstate.edu) (<https://physics.okstate.edu/>).

## Minors

- Physics (PHYS), Minor (<http://catalog.okstate.edu/arts-sciences/physics/physics-minor/>)

## Faculty

Flera Rizatdinova, PhD—Professor and Head

**Regents Professors:** Kaladi Babu, PhD

**Professors:** Donna K. Bandy, PhD; Eric Benton, PhD; Joseph Haley, PhD; Alexander Khanov, PhD; Yingmei Liu, PhD (Noble Chair); David McIlroy, PhD; Al Rosenberger, PhD; Aihua Xie, PhD

**Associate Professors:** Mario Borunda, PhD; Donghua Zhou, PhD

**Assistant Professors:** Thomas Bilitewski, PhD; Vedran Brdar, PhD; Julius De-Rojas, PhD; Dorival Goncalves-Netto, PhD; Mayukh Lahiri, PhD; Derek Meyers, PhD; Andrew Yost, PhD

**Teaching Assistant Professor:** Kim Zoldak, PhD

**Emeriti Professors:** Bruce Ackerson, PhD; Robert Hauenstein, PhD; Joel J. Martin, PhD; Stephen W.S. McKeever, PhD (Regents Professor); John W. Mintmire, PhD (Regents Professor); Satya Nandi, PhD (Regents Professor); Jacques H.H. Perk, PhD; Peter M.A. Sherwood, PhD (Regents Professor); Peter O. Shull, PhD; James P. Wicksted, PhD