

# Physics Courses

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## Courses

### **PHYS 5195. Graduate Seminar.**

Graduate Seminar: May be repeated three times for credit.

**Department:** Physics

**1 Credit Hour**

**1 Total Contact Hour**

0 Lab Hours

1 Lecture Hour

0 Other Hours

**Classification Restrictions:**

Restricted to class of DR

### **PHYS 5196. Graduate Research in Physics.**

Graduate Research in Physics: This course may be taken as often as needed, but no more than 3 semester credit hours may be applied to satisfy the requirements for the master's degree. A student will receive only a P or F grade, except when the student has filed a preliminary degree plan in which this course appears. Prerequisite: Department approval.

**Department:** Physics

**1 Credit Hour**

**1 Total Contact Hour**

0 Lab Hours

0 Lecture Hours

1 Other Hour

**Classification Restrictions:**

Restricted to class of DR

### **PHYS 5321. Mechanics.**

Mechanics: Lagrange's equations, nonholonomic constraints, Hamilton's principles, two-body central force, rigid body dynamics, Lagrangian relativistic mechanics, Hamilton and Hamilton-Jacobi equations, canonical transformations. Prerequisite: PHYS 3352. Offered Fall semester.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Classification Restrictions:**

Restricted to class of DR

**Prerequisite(s):** (PHYS 3352 w/C or better)

### **PHYS 5325. Mathematical Physics.**

Mathematical Physics: Linear systems, special functions, complex variables, and tensor problems in physics. Offered Fall semester.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Classification Restrictions:**

Restricted to class of DR

**PHYS 5341. Electrodynamics.**

Electrodynamics: Boundary value problems, polarization and stress tensor. Conservation laws and energy momentum tensor. Relativistic electrodynamics. Covariant form of field equations. Potentials and gauge invariance. Prerequisite: PHYS 4342.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Classification Restrictions:**

Restricted to class of DR

**Prerequisite(s):** (PHYS 4342 w/C or better)

**PHYS 5361. Quantum Mechanics.**

Quantum Mechanics: Solution of the Schrodinger wave equation for discrete and continuous energy eigenvalues; representation of physical variables as operators and the matrix formulation of quantum mechanics; approximation methods. Prerequisite: PHYS 4356.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Classification Restrictions:**

Restricted to class of DR

**Prerequisite(s):** (PHYS 4356 w/C or better)

**PHYS 5365. Advanced Statistical Mechanics.**

Advanced Statistical Mechanics: Classical and quantum statistics of systems in equilibrium. Treatment of fluctuations and transport phenomena. Introduction to many body problems. Prerequisite: PHYS 3331 with a grade of "C" or better.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Classification Restrictions:**

Restricted to class of DR

**Prerequisite(s):** (PHYS 3331 w/C or better)

**PHYS 5371. Solid State Physics.**

Solid State Physics: Electromagnetic, elastic and particle waves in periodic lattices as applied to the electrical, magnetic and thermal properties of solids. Prerequisite: PHYS 4356 or department approval.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Classification Restrictions:**

Restricted to class of DR

**Prerequisite(s):** (PHYS 4356 w/C or better)

**PHYS 5391. Research Problems in Physics.**

Research Problems in Physics: Required course for the 36-hour non-thesis option. Requires two copies of a type-written report. May be repeated for credit; maximum credit allowed six hours. May not be counted as thesis research but may be taken one time as a preparatory investigation course prior to the beginning of thesis research.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**Classification Restrictions:**

Restricted to class of DR

**PHYS 5393. Special Topics in Physics.**

Special Topics in Physics: Topics to be announced. May be repeated for credit.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Classification Restrictions:**

Restricted to class of DR

**PHYS 5396. Graduate Research in Physics.**

Graduate Research in Physics: This course may be taken as often as needed, but no more than 3 semester credit hours may be applied to satisfy the requirements for the master's degree. A student will receive only a pass/fail grade except when the student has filed a preliminary degree plan in which this course appears. Prerequisite: Department approval.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Classification Restrictions:**

Restricted to class of DR

**PHYS 5398. Thesis.**

Thesis: Prerequisite: Department approval.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**PHYS 5399. Thesis.**

Thesis. Prerequisite: PHYS 5398 and department approval.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**Prerequisite(s):** (PHYS 5398 w/P or better)

**PHYS 5696. Graduate Research in Physics.**

Graduate Research in Physics (0-0-6) This course may be taken as often as needed, but no more than three semester hours may be applied to satisfy the requirements for the master's degree. A student will receive only a pass/fail grade except when the student has filed a preliminary degree plan in which this course appears.

**Department:** Physics

**6 Credit Hours**

**6 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

6 Other Hours

**Classification Restrictions:**

Restricted to class of DR

**PHYS 6195. Seminar.**

The purpose of this course is to help the students develop communication skills for scientific presentations. Keywords: Talks, poster, elevator speech.

**Department:** Physics

**1 Credit Hour**

**1 Total Contact Hour**

0 Lab Hours

1 Lecture Hour

0 Other Hours

**PHYS 6196. Doctoral Research.**

The purpose of this course is to help the students develop communication skills for scientific presentations. Keywords: Talks, poster, elevator speech.

**Department:** Physics

**1 Credit Hour**

**1 Total Contact Hour**

1 Lab Hour

0 Lecture Hours

0 Other Hours

**PHYS 6296. Doctoral research.**

The purpose of this course is to help the students develop communication skills for scientific presentations. Keywords: Talks, poster, elevator speech.

**Department:** Physics

**2 Credit Hours**

**2 Total Contact Hours**

2 Lab Hours

0 Lecture Hours

0 Other Hours

**PHYS 6321. Mechanics.**

This course introduces Lagrange's equations, nonholonomic constraints, Hamilton's principles, two-body central force, rigid body dynamics, coupled oscillations, Lagrangian relativistic mechanics, Hamilton and Hamilton-Jacobi equations, canonical transformations for description of dynamics of particle and systems. Keywords: Calculus of variation, Lagrangian, Hamiltonian, rotation.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Prerequisite(s):** (PHYS 3352 w/C or better)

**PHYS 6325. Mathematical Physics.**

This course includes Linear Systems, special functions, complex variables, and tensor problems in physics. Keywords: Matrix Algebra, eigenvalue problem, complex numbers.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**PHYS 6331. Nuclear and Particle Physics.**

The course provides a description of the models of Nuclear Structure, relativistic nuclear and particle physics. Introduction to Field theory, Quantum chromodynamics, electroweak interactions, standard model. Keywords: Nuclear forces, Fermi gas, Shell model, Lattice Gauge model, standard model, weak interactions.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Prerequisite(s):** (PHYS 4355 w/C or better)

**PHYS 6341. Electrodynamics I.**

This course covers the following topics in electromagnetic theory: Boundary value problems, polarization and stress tensor, Conservation laws and energy momentum tensor, Relativistic electrodynamics, Covariant form of field equations, Potentials and gauge invariance. Keywords: Laplace and Poisson Equations, Maxwell's equations, electromagnetic wave.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Prerequisite(s):** (PHYS 4341 w/C or better)

**PHYS 6342. Electrodynamics II.**

This course is a continuation of PHYS 5341 Electrodynamics I. It introduces the students to time dependent electromagnetic phenomena. The broad topics are: Maxwell's equations, Green's function, Electromagnetic waves, Electromagnetic radiation, scattering and multiple radiation fields, Lagrangian formalism for continuum fields, radiation from accelerated charges, invariance under Lorentz transformations and interaction of charges with radiation. Keywords: Green Function, Polarization, Radiation, Scattering.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Prerequisite(s):** (PHYS 6341 w/B or better)

**PHYS 6355. Experimental Methods.**

This course will introduce the students to various experimental methods used for material synthesis both in bulk and nanostructural form and their characterization techniques and analysis. At the end of the course the students should be able to determine crystal phase structure, morphology, composition and understand the results of measurements of physical properties such as magnetic, optical, and electronic properties. Keywords: Crystallography, spectroscopy, calorimetry, microscopy.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Prerequisite(s):** (PHYS 4341 w/C or better AND PHYS 4356 w/C or better)

**PHYS 6361. Quantum Mechanics I.**

Solution of the Schrodinger wave equation for discrete and continuous energy eigenvalues; representation of physical variables as operators and the matrix formulation of quantum mechanics; approximation methods. Keywords: Probability, wave function, Hilbert space, wave-particle duality.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Prerequisite(s):** (PHYS 4355 w/C or better)

**PHYS 6362. Quantum Mechanics II.**

It includes Schrodinger equation and its solutions as applied to simple physical problems, elementary approximate methods, and scattering theory. Broad topics to be covered are: Perturbation theory, Variational method, Identical particles, Exchange interaction, emission and absorption of radiation, scattering phenomenon, Partial waves and phase shifts, relativistic quantum mechanics. Keywords: Fermi Golden rule, Born approximation, Stimulated emission.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Prerequisite(s):** (PHYS 4355 w/C or better)

**PHYS 6363. Atomic and Molecular Physics.**

The course provides a description of the many-electron atoms and molecules and their interaction with electromagnetic fields. Topics to be covered are: helium and multielectron atom, Mean-Field approach, fine structure and Lamb shift, hyperfine structure and magnetic fields, two-state systems: resonance, interaction of an atom with an electromagnetic field, diatomic molecules, molecular bonding and orbitals, molecular rotational and vibrational spectra, electron spectra of molecules, Franck-Condon principle.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Prerequisite(s):** (PHYS 4356 w/C or better)

**PHYS 6364. Density Functional Theory A-Z.**

This course is designed to introduce the students to the concepts involved electronic structure calculations using density functional theory. The topics that will be covered in lectures are one-electronic system, many-electron Hamiltonian, wavefunction, Hartree approximation, Hartree-Fock method, electron-electron exchange interaction, density functional approximations, self-interaction problem in DFT. The students to use electronic structure code to calculate properties of atoms and molecules. Keywords: Generalized gradient approximation, Kohn-Sham orbitals, Mean-field

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

2 Lab Hours

1 Lecture Hour

0 Other Hours

**Prerequisite(s):** (PHYS 4356 w/C or better)

**PHYS 6365. Advanced Statistical Mechanic.**

Classical and quantum statistics of systems in equilibrium, Treatment of fluctuations and transport phenomena, Introduction to many body problems.

Keywords: Boltzmann statistics, Fermi-Dirac Statistics, Thermodynamic potentials

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Prerequisite(s):** (PHYS 3331 w/C or better)

**PHYS 6366. Spin Physics.**

This course prepares students for the emerging research areas at the interface of molecular magnetism, spin physics, quantum sensing, and spin-dependent electron transfer. Keywords: Angular momentum, Spin Hamiltonian, spin-orbit coupling, tunneling.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Prerequisite(s):** (PHYS 4356 w/C or better)

**PHYS 6368. Quantum Computing.**

This course provides a self-contained introduction to quantum information and quantum computing science. The course explains how quantum computing is different from classical computing and how it can be useful for solving complex problems. Basic elements of a quantum computer such as qubit, quantum gates, qubit readout, coherence, entanglement are introduced. Introduces to various physical implementations of quantum computing devices and applications such as Shor's algorithm, quantum simulation and quantum communications. Keywords: Quantum algorithm, Bell States, coherence.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Prerequisite(s):** (PHYS 4355 w/C or better)

**PHYS 6371. Solid State Physics.**

This course provides an introduction to Electromagnetic, elastic and particle waves in periodic lattices as applied to the electrical, magnetic and thermal properties of solids. Keywords: Crystal structure, lattice, energy bands, phonon.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Prerequisite(s):** (PHYS 4356 w/C or better)

**PHYS 6375. Computational Biophysics.**

The course is designed to provide comprehensive coverage of major areas of Computational Biophysics: objects as DNA, RNA, protein and membrane; reviewing the forces and effects acting between atoms and among the molecules; modeling protein folding and protein stability, accompanied by practical exercises. Keywords: Force field, Dispersion forces, charge-dipole interaction.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

2 Lab Hours

1 Lecture Hour

0 Other Hours

**PHYS 6381. Astrophysics.**

This course will introduce the students to Mathematical techniques and analytical derivations of the main astrophysical processes, the physics of stellar interiors and atmospheres, stellar evolution, the interstellar medium, the structure and evolution of galaxies, and relativistic astrophysics. Keywords: white dwarfs, orbital dynamics, gravitational waves.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**PHYS 6391. Research Problems in Physics.**

Research Problems in Physics: Required course for the 36-hour non-thesis option. Requires two copies of a type-written report. May be repeated for credit; maximum credit allowed six hours. May not be counted as thesis research but may be taken one time as a preparatory investigation course prior to the beginning of thesis research.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**PHYS 6393. Special Topic.**

Special topics in Physics. This course can be taken to include extra courses necessary for research. This course can be taken twice.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**Major Restrictions:**

Restricted to majors of PHYS

**PHYS 6396. Doctoral Research.**

This course will be taken by the doctoral student working under supervision of a research advisor toward PhD degree.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**Major Restrictions:**

Restricted to majors of PHYS

**PHYS 6398. Dissertation I.**

The student will begin to write a dissertation based on the graduate research work done. The dissertation will be directed by the research advisor. This course will be taken in the first semester that the students starts to write the dissertation.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**Major Restrictions:**

Restricted to majors of PHYS

**PHYS 6399. Dissertation II.**

The student will complete a dissertation based on the graduate research work done. The dissertation will be directed by the research advisor. The submission and successful defense of a dissertation is required to earn the degree.

**Department:** Physics

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**Prerequisite(s):** (PHYS 6398 w/C or better)

**PHYS 6696. Graduate Research in Physics.**

Graduate Research in Physics (0-0-6) This course may be taken as often as needed, but no more than three semester hours may be applied to satisfy the requirements for the master's degree. A student will receive only a pass/fail grade except when the student has filed a preliminary degree plan in which this course appears.

**Department:** Physics

**6 Credit Hours**

**6 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

6 Other Hours