

# Department of Physics

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**FACULTY** Professors Craig, Early, Wang; Associate Professors Kimberlin (chair), Roos; Assistant Professor Lozano.

## Program

The Department of Physics has designed its programs and courses in physics and astronomy with two principal objectives in mind. First, for citizens to lead productive lives it is important that individuals be scientifically and technologically literate. Therefore, the department offers physics courses that are accessible to all of the university's students. Several of our courses have been especially tailored for the nonscientist. Second, a technological society has need for teachers, scientists and engineers who have a broad and deep understanding of the basic physical laws. The department has programs and courses designed for students majoring in scientific and technical areas that will prepare them for professional careers or advanced study in these areas.

The Department of Physics offers introductory courses that cover the entire range of preparation in science and mathematics found at the university. Some require little or no science or mathematics preparation. Examples of such courses are PHY 100, PHY 123, and AST 300. Most of the other courses offered by the department require some prior exposure to science and mathematics. A few are available only to persons holding a bachelor's degree in physical science or engineering. Therefore, students wishing to study physics will find entry-level courses appropriate to their abilities and preparation.

The Department of Physics offers majors in the College of Liberal Arts and Sciences and the College of Engineering and Technology. There are four variations in the majors taken from the College of Liberal Arts and Sciences. These variations differ in the particular courses taken in the department, but differ more in the courses taken in other departments. The department also offers a minor. The specific program a student follows depends to a great extent on the particular interests of the student. Each student must work with a faculty advisor to plan an interesting course of study that satisfies the student's needs and all department, college, and university requirements.

### **Physics, Mathematics, and Computer Science and Information Systems Requirements for All Physics Majors**

All students majoring in the various programs in physics are required to complete the following courses in physics: PHY 110, 199, 201, 202 or 303, 301, 305, 350, 463, 467, and 501.

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Students who receive a grade of B or better in PHY 107 and 108 may substitute these courses for PHY 110 and 201. In addition to these courses students must complete a combination of theory and laboratory courses in physics at the 300 to 500 level. Students must complete no fewer than 30 semester hours of physics courses. All physics majors are expected to present the results of their research experience while enrolled in PHY 563 at a departmental colloquium. Mathematics courses required by all physics majors are MTH 121, 122, 207, 223, and 224. The computer science course CS 106 or equivalent is also required.

## Liberal Arts and Sciences Physics Major

The students who seek this major can generally be grouped into three categories.

- 1) Professional Physicist: these students intend to continue their formal education in physics by pursuing a graduate degree in physics.
- 2) Professional School Preparatory: these students are using the physics major as preparation for entering professional school programs such as medicine, engineering, or law.
- 3) Second Major: these students use the physics major to develop their problem solving skills and for increasing their understanding of the physical universe while choosing their primary major in areas such as computer science, chemistry, or mathematics.

Students in all three categories will complete the core courses as indicated above. In addition all of these students must complete two additional courses in physics selected from the following: PHY 306, 320, 345, 350, 361, 502, 568, and AST 300.

Students seeking to become professional physicists are strongly encouraged to complete all of these courses, and in addition MTH 510; CHM 110 and 111; or CHM 112 and three additional mathematics courses chosen from the following: MTH 309, 325, 326, 403, 420, 421, 501, 502, and 514.

## Secondary Education-Physics Teaching Major

Students preparing to teach physics at the high-school level must complete the requirements for a secondary teaching certificate to be certified in the state of Illinois. These requirements are listed in this catalog under the Department of Teacher Education (Secondary Programs), and consist of

a minimum of 38 semester hours in professional education courses. The courses used to fulfill the General Education requirement must also be chosen to fulfill certification requirements. Secondary Education-Physics Teaching majors are also required to take courses that will qualify them to be certified in a second teaching area which will require that from 6 to 15 semester hours be completed in the area chosen. Students must consult with advisors from both the Physics Department and the College of Education and Health Sciences. In addition to the courses required of all physics majors the students selecting this variation in the physics major must complete two courses from the following: PHY 306, 320, 345, 361, 501 and 568; AST 300.

### Engineering Physics

The engineering physics major is offered through the College of Engineering and Technology. Details of this program are found in the College of Engineering and Technology section of this catalog. Engineering physics majors must meet all the requirements of the University and College of Engineering and Technology in addition to taking the required courses in physics and mathematics indicated above. Faculty advisors from both physics and engineering advise students who major in engineering physics.

### Physics Minor

The physics minor consists of PHY 107 or 110; 108 or 201; 202 and three additional elective courses at the 300 level chosen to fit the student's special interests. Students may select from the following: AST 300; PHY 301, 305, 320, 345, 350 (two semester hours), 361 and 306.

### Suggested Program for the LAS Physics Major

The schedule of courses shown below lists only the physics courses required by all LAS physics majors. Elective courses would then be chosen to fulfill the requirements for the particular variation chosen by the student. Some course requirements may be met through Advanced Placement tests, proficiency examinations, or transfer credit

#### Freshman Year

##### First Semester

Gen. Ed. Western Civilization.....	3
PHY 199 Physics Seminar.....	1
CHM 110 General Chemistry I.....	3
CHM 111 General Chemistry I Laboratory .....	1
ENG 101 Composition .....	3
MTH 121 Calculus I.....	4
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	15

#### Second Semester

PHY 110 University Physics I.....	4
Gen. Ed. Fine Arts.....	3
Gen. Ed. Social Forces.....	3
COM 103 Oral Communication Process .....	3
MTH 122 Calculus II.....	4
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	17

#### Sophomore Year

##### First Semester

PHY 201 University Physics II.....	4
CS 106 Introduction to Programming and CS.....	3
Gen. Ed. Social Forces (Economics).....	3
MTH 223 Calculus III .....	4
Gen. Ed. Human Values (Philosophy) .....	3
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	17

##### Second Semester

PHY 202 Applied Quantum Physics <b>or</b> Elective.....	3
PHY 350 Applied Quantum Physics Lab.....	1
Gen. Ed. Non-Western Civilization.....	3
Elective .....	3
MTH 224 Elementary Differential Equations .....	4
MTH 207 Elem. Linear Algebra with Applications .....	3
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	17

#### Junior Year

##### First Semester

PHY 305 Electricity and Magnetism.....	3
PHY 301 Classical Mechanics.....	3
English: 300-Level Junior Composition .....	3
Gen. Ed. Human Values (Literature) .....	3
Elective .....	3
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	15

##### Second Semester

PHY 303 Quantum Physics <b>or</b> Elective.....	3
PHY 350 Applied Quantum Physics Lab.....	1
Physics Elective .....	3
Electives.....	9
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	16

#### Senior Year

##### First Semester

PHY 501 Quantum Mechanics I.....	3
PHY 563 Special Problems in Physics .....	1
PHY 467 Statistical and Thermal Physics.....	3
Physics Elective .....	3
Electives.....	6
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	16

## College of Liberal Arts and Sciences

### Second Semester

PHY 563 Special Problems in Physics .....	1
Physics Elective .....	6
Electives .....	9
	16
Total Hours	129

### Suggested Program for Secondary Education - Physics Teaching Major

A student preparing to teach physics at the high-school level should follow the sequence shown below. Students who plan to teach in states other than Illinois should be aware that some of the education courses in this sequence might not apply toward certification in those states.

A second teaching field is required. The student must consult an advisor for specific requirements for the second teaching field.

#### Freshman Year

##### First Semester

PHY 110 University Physics I .....	4
PHY 199 Physics Seminar .....	1
MTH 121 Calculus I .....	4
ENG 101 English Composition .....	3
Gen. Ed. (SF) .....	3
CHM 110 Gen. Chem. I or CHM 300 .....	3
	18

##### Second Semester

PHY 201 University Physics II .....	4
MTH 122 Calculus II .....	4
COM 103 Oral Communication Process .....	3
ETE 115 Schools and Schooling in American Society .....	3
ETE 116 Field Experience for ETE 115 .....	1
Gen. Ed. - Human Values (ENG 115 or 121) .....	3
	18

#### Sophomore Year

##### First Semester

PHY 202 Applied Quantum Physics .....	3
PHY 305 Applied Quantum Physics Laboratory .....	1
MTH 223 Calculus III .....	4
CS 106 Intro. to Programming and Computer Science .....	3
Gen. Ed. CIV 100 Western Civilization .....	3
ETE 100 Technology Applications .....	1
ETE 280 Exploring Diversity .....	3
	18

### Second Semester

PHY 320 Optics .....	3
PHY 350 Optics Laboratory .....	1
MTH 224 Elem. Differential Equations .....	4
ETE 225 Human Development .....	4
BIO 121 Life Sci. I or BIO 300 .....	3
FCS 203 or NUR 163, 220, 221, 263, or 376 .....	3
	18

#### Junior Year

##### First Semester

PHY 305 Electricity and Magnetism .....	3
Second Teaching Area .....	3
English: 300-level Junior Composition .....	3
ETE 360 Teaching Reading in the Content Field .....	3
ETE 370 General Secondary Methods I .....	3
Gen. Ed. Fine Arts .....	3
	18

##### Second Semester

PHY 301 Classical Mechanics .....	3
PHY 306 Electromagnetic Waves .....	3
Second Teaching Area .....	3
ETE 374 Methods of Teaching Secondary Science .....	2
ETE 371 General Secondary Methods II .....	3
ETE 379 Novice Teaching in the Secondary School .....	2
	16

#### Summer

Gen. Ed. Non-Western Civilization .....	3
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#### Senior Year

##### First Semester

PHY 501 Quantum Mechanics I .....	3
PHY 467 Statistical and Thermal Physics .....	3
Second Teaching Area .....	2
AST 300 Astronomy .....	3
ETE 342 .....	3
Gen. Ed. (Humanities Phil.) .....	3
	17

##### Second Semester

PHY 361 Electronics .....	3
PHY 563 Special Problems in Physics .....	2
ETE 490 Student Teaching Professional Portfolio .....	1
ETE 499 Student Teaching in the Secondary Schools .....	10 or 13
	16 or 19
Total Hours	142-145

## Course Descriptions

### Astronomy

#### **AST 300 Astronomy: Our Glimpse of the Cosmos 3 hrs. (Gen. Ed. TS)**

Various scientific views of the cosmos; how modern astronomy has enlightened and broadened these views. Relationships between man, technology, and the universe through scientific knowledge of planets, stars, galaxies, and the cosmos will be investigated. Experimental discoveries in astronomy are examined, analyzed, and discussed. Prerequisites: junior standing; a basic science course.

#### **AST 310 Astronomy and Astrophysics 3 hrs.**

Scientific and contemporary study of broad range of astronomy and astrophysical topics: overview of the universe, superclusters of galaxies, stars, planetary systems, and subsystems of objects. Analytical presentations of special topics: stellar evolution, quasi-stellar objects, black holes, and cosmological concepts. Scientific-technical elective for science and engineering majors. Prerequisites: junior standing; one year of analytical science.

### Physics

#### **PHY 100 Fundamental Physics Concepts 4 hrs. (Gen. Ed. FS)**

Algebra-based course for students with minimal physics background. Topics introduced include Newton's laws of motion, electromagnetism, thermodynamics, optics, and atomic theory. Emphasis is on basic physical principles. Includes laboratory.

#### **PHY 107 General Physics I 4 hrs. (Gen. Ed. FS)**

Algebra- and trigonometry-based introductory physics course which covers Newtonian mechanics and conservation laws; fluid statics and dynamics; vibrations, waves, and sound; laws of thermodynamics. Includes laboratory. Prerequisite: high school physics or PHY 100.

#### **PHY 108 General Physics II 4 hrs. (Gen. Ed. FS)**

Continuation of PHY 107. Electric and magnetic fields; electromagnetic induction; electromagnetic waves; geometrical and physical optics; the special theory of relativity; quantum theory, atomic physics, and nuclear and particle physics. Includes laboratory. Prerequisites: PHY 107; MTH 115.

#### **PHY 110 University Physics I 4 hrs. (Gen. Ed. FS)**

Calculus-based introductory physics course for scientists and engineers that covers Newton's laws of motion; conservation laws for momentum, energy, and angular momentum; fluid statics and dynamics; laws of thermodynamics. Includes laboratory. Prerequisites: high school physics or PHY 100; MTH 115 or 121.

#### **PHY 123 Physical Science, Basis for a Technical Society 3 hrs. (Gen. Ed. FS)**

A course for non-science students with minimal preparation in mathematics and science. Emphasizes basic concepts from the physical sciences and their significance for a scientifically literate society. Topics in physics, chemistry, computing, energy, and astronomy will be covered from an applications perspective. Students with prior college physics courses may not register for this course.

#### **PHY 199 Physics Seminar for New Physics Majors 1 hr.**

Orientation for students interested in a physics career. Prerequisites: freshman or sophomore standing; physics major or minor.

#### **PHY 201 University Physics II 4 hrs. (Gen. Ed. FS)**

Continuation of PHY 110 covering electric fields and DC circuits; magnetic fields, electromagnetic induction and AC circuits; oscillations and waves; Maxwell's equations; and geometrical and physical optics. Includes laboratory. Prerequisites: PHY 107 and permission of instructor or PHY 110. Corequisite: MTH 116 or 122.

#### **PHY 202 Applied Quantum Physics 3 hrs. (Gen. Ed. FS)**

Introduction to relativity and relativistic mechanics; quantum theory with applications to atomic and molecular physics; condensed matter physics; nuclear and particle physics. Prerequisite: PHY 201. Corequisite: MTH 223. Students who desire a lab experience should also enroll in the appropriate section of PHY 350.

#### **PHY 301 Classical Mechanics 3 hrs.**

Particle kinematics; Newtonian mechanics; classical gravitation; Lagrangian and Hamiltonian dynamics; linear oscillations; nonlinear oscillations; central force and planetary motion; collisions between particles; motion in noninertial systems. Prerequisites: PHY 201; MTH 224.

#### **PHY 303 Quantum Physics 3 hrs.**

Foundations of quantum theory: deBroglie's postulate, Bohr model of the atom, and the Schrodinger equation; applications of quantum theory to atoms, solids, nuclei, and particles; relativity. Prerequisite: PHY 201. Corequisite: the appropriate section of PHY 350.

#### **PHY 305 Electricity and Magnetism 3 hrs.**

Introduction to vector calculus; electrostatics in vacuum and dielectrics including boundary value problems; method of images, steady currents, and magnetostatics in vacuum; magnetic materials. Prerequisites: PHY 201; MTH 224.

#### **PHY 306 Electromagnetic Waves 3 hrs.**

Plane electromagnetic waves in vacuum, polarizable materials, and conductors; reflection and refraction, guided waves, and radiation of electromagnetic waves. Prerequisite: PHY 305.

## College of Liberal Arts and Sciences

**PHY 320 Optics** **3 hrs.**  
Geometrical optics: matrix methods, mirrors, lenses, fibers, thick optics, optical instruments; physical optics including interference, diffraction, polarization, lasers, and holography. Prerequisites: PHY 202 or equivalent. Corequisite for all physics majors or minors: the appropriate section of PHY 350.

**PHY 345 Radiation Biology** **3 hrs.**  
Role of ionizing radiation in the biological and medical sciences: production, detection, and measurement of radiation, physically and biologically; interaction of radiation with matter at molecular, cellular, whole body, and whole population levels; applications of radiation as a useful and experimental tool. Cross listed as BIO 345. Prerequisites: PHY 108; MTH 115 or 121; C or better in BIO 124.

**PHY 350 Advanced Physics Experiments** **1-2 hrs.**  
Laboratory: design of experiments and techniques of measurement, particularly electronic instrumentation, in investigating fundamental relationships in all areas of physics. One three-hour laboratory session per week per credit hour required. May be repeated for maximum of 4 hrs. credit. Sections of this course may provide a lab component for PHY 202, 303, and 320. Prerequisite: consent of department chair.

**PHY 361 Electronics** **3 hrs.**  
Electronic principles with application to measurement devices utilized in science research. Self-paced instruction and laboratory work. Prerequisites: PHY 108 or 201; MTH 116 or 122.

**PHY 467 Statistical and Thermal Physics** **3 hrs.**  
Rigorous theoretical treatment of classical thermodynamics with applications of the first and second laws, and an introduction to statistical mechanics, including quantum statistics, canonical and grand canonical ensembles, general properties of the partition function, applications of statistical mechanics to fluid and solid systems, and the Ising model. Prerequisites: PHY 202 or 303, 301; knowledge of a programming language; consent of instructor.

**PHY 501 Quantum Mechanics I** **3 hrs.**  
Inadequacies of classical physics when applied to problems in atomic and nuclear physics. Development of mathematical formalism used in basic quantum theory. Applications to simple models of physical systems. Prerequisites: PHY 202, 301, 306; consent of instructor. MTH 207 recommended.

**PHY 502 Quantum Mechanics II** **3 hrs.**  
Mathematical formalism of quantum mechanics. Applications to problems of electron spin and many-particle systems. Development of approximation techniques with applications to complex physical systems. Prerequisite: PHY 501.

**PHY 541 Physics Basics** **2 hrs.**  
Numerical and graphical analysis of data; basic mechanics including Newton's laws and gas laws; hydrostatics and hydrodynamics; energy conservation principles; thermal physics; electricity and magnetism; and solubility and transport processes. Only students in the Nurse Administered Anesthesia Program may register.

**PHY 545 Biophysics** **3 hrs.**  
Applications of physics principles and methods to investigation of biological systems. Emphasis on physical environmental effects on biological systems. Cross listed as BIO 545. Prerequisites: PHY 108 or 201; senior standing; or consent of instructor. PHY 345 recommended.

**PHY 555 Independent Readings** **1-3 hrs.**  
Individually assigned reading assignments of relevant topics in physics or astronomy. Prerequisites: senior or graduate standing; background appropriate to the study; consent of instructor.

**PHY 563 Special Problems in Physics** **1-3 hrs.**  
Qualified students work on an individually assigned problem and prepare oral and written reports on the problem solution. Approved for off-campus programs when required. May be repeated for a maximum of 6 hrs. credit. Prerequisites: physics preparation sufficient for the problem; consent of instructor and Department Chair.

**PHY 568 Condensed Matter Physics** **3 hrs.**  
Introduction to the physics of the solid state and other condensed matter especially for students of physics, materials science, and engineering; structure of crystals; molecular binding in solids, thermal properties, introduction to energy band structure and its relation to charge transport in solids; semiconductors; superconductivity. Prerequisite: PHY 202 or 303; MTH 224; consent of instructor.