

## Physics (PHYS)

*McDonald (chair), Lin*

The mission of the physics department is to imbue all students, regardless of major, with: (1) a basic understanding of the physical world around them; (2) an understanding of the process of doing science; (3) the basic skills necessary to succeed in science and in life; (4) the basic knowledge and reasoning ability to make ethical decisions on the use of science and technology in their own lives and in society; (5) a sense of responsibility for the path that science will take in the 21st century; and (6) an appreciation of the wonders of God's world as revealed through the study of physics.

Our educational philosophy is based on the following values: (1) excellence – we expect excellence from our faculty and students in all classes; (2) hard work – the pursuit of truth through physics requires diligence, determination and perseverance; (3) empowerment – students who succeed at physics will know they can succeed at anything; (4) responsibility – with knowledge comes the responsibility to assure that knowledge is applied ethically and carefully; (5) teamwork – no matter what background one comes from, physics students are united by the common goals; and (6) passion – the path to true understanding can only be pursued by the passionate learner.

The department sets several outcomes for all of its students: (1) to acquire a basic understanding of physical principles and their applications at a level appropriate to the student's intended academic path; (2) to develop a basic mastery of the skills necessary to undertake scientific inquiry, including: graphical and statistical analysis of data, computational proficiency, mathematical competency, and the use of computers; (3) to develop of their critical thinking and analytical skills as well as mastery of problem solving techniques; (4) to learn to communicate physics effectively both orally and in various written formats and to read physics material at various levels; (5) to consider the ethical responsibilities of a physicist to society; and (6) to consider the history and philosophy of physics and its relationship to other intellectual disciplines.

### Major requirements for the B.A. degree in Physics

#### Required semester hours

36 sh

#### Prerequisites and supporting courses

MATH 1510, 1520, 2030

#### Required core courses

PHYS 1210, 1220, 1330, 1410, 1510, 2110, 2510, 2520, 3310, 3410 or 3510, 4030

#### Electives

4 sh from: PHYS 1060, 1070, 2060, 2950, 3010, 3110, 3210, 3220, 3410, 3510, 3910, 3920, 3930, 3940, 3950, 4010, 4910, 4930, 4950, 4970

#### Notes and restrictions

Recommended MATH 3100 (4 sh)

In addition all students will be required to write a senior thesis. Students may undertake some type of original research project which will result in a written paper to be submitted to the department for review. Students should also present their research at either a departmental symposium or at an organized off-campus meeting.

#### Special programs

Students completing the 3-2 Engineering program will receive a B.A. in Physics from North Park. The 3-2 engineering program consists of 3 years at North Park at which time the student transfers to an accredited engineering school. It is recommended that students take the following courses while at North Park: PHYS 1210, 1220, 1330, 1510 2110, 2510, 2520, 3310, MATH 1510, 1520, 2030, 3100, CHEM 1150, 1160, and all of the North Park general education requirements.

### Major requirements for the B.S. degree in Physics

#### Required semester hours

48 sh

#### Prerequisites and supporting courses

MATH 1510, 1520, 2030

#### Required core courses

PHYS 1210, 1220, 1330, 1410, 1510, 2110, 2510, 2520, 3110, 3310, 3410, 3510, 4010, 4030

#### Electives

6 sh from: PHYS 1060 or 1070; 2060, 2950, 3010, 3210, 3220, 3910, 3920, 3930, 3940, 3950, 4000, 4910, 4930, 4950

#### Notes and restrictions

Recommended MATH 3100 (4 sh)

All students are required to take a comprehensive exam. Students may choose to take the GRE Physics subject test or a departmental comprehensive exam. In addition all students will be required to write a senior thesis. Students will undertake some type of original research project. A written paper must be submitted to the department for review. Students must also present their research at either a departmental symposium or at an organized off-campus meeting.

#### Honors

Students must complete 45 sh of physics. In addition to the above requirements for a B.S. in Physics students must also complete a minimum of 3 sh of either PHYS 4930 or 4950. They must also enroll in a minimum of 3 sh of PHYS 4000 spring semester of their fourth year. Research for physics 4930/4950 may be carried out either on campus or at an approved off-campus site. Students will prepare a written paper which must also be presented orally to an appropriate group. Students must submit a proposal of their intended research project for departmental approval prior to enrollment in 4930/4950. For general Departmental Honors requirements and PHYS 4000 course description, see appropriate sections of this catalog.

### Minor requirements in Physics

#### Required semester hours

22 sh

#### Required core courses

10 sh of Physics courses numbered 2000 or above; and PHYS 4030

#### Electives

12 sh from: PHYS 1060, 1070, 1110, 1120, 1210, 1220, 1330, 1410, 1510, 2060, 2110, 2510, 2520, 2950, 3010, 3110, 3210, 3220, 3310, 3410, 3510, 3910, 3920, 3930, 3940, 3950, 4010, 4910, 4930, 4950, 4970

**Notes and restrictions**

Recommended Math 1510, 1520, 2030, 3100

GE Designates a course that fulfills all or part of a General Education (G.E.) requirement; see the General Education Program section of the catalog for more information.

**1000 Conceptual Physics (2 sh) GE**

This course is intended to be an introductory algebra-based course in physical science. The course will cover selected topics in physics and applied physics which may include: introduction to astronomy, introduction to geology, introduction to meteorology, or amusement park physics. In each case, emphasis will be placed on the role of technology in society, with emphasis on the environment, as well as physics as a human endeavor. Lab is included in this course. Basic competency in algebra is assumed.

**1020 Light (2 sh) GE**

This course is intended to be an introductory course in physical science with minimum mathematics. The course will cover selected topics in optics and light including the principles of production and propagation of light waves with particular emphasis on design and analysis of optical equipment. Geometrical and physical optics, lasers, and their applications will also be covered. Lab is included in this course. Registration based on designated score on the Math Placement Exam or permission of instructor.

**1030 Energy (2 sh)**

This course is intended to be an introductory course in physical science with minimum mathematics. The course will cover selected topics dealing with various forms of energy including the concepts of atomic, nuclear and electrical energy, work, power, conservation of energy, heat, and entropy. Emphasis will be placed on energy and the environment, energy resources, alternative forms of energy production, pollution, and the economics of energy use. Lab is included in this course. Registration based on designated score on the Math Placement Exam or permission of instructor.

**1050 Physics of Sports (2 sh) GE**

This course is intended to be an introductory, algebra-based course in physical science. The course will cover selected topics in physics and their applications to a wide variety of sports. Data acquisition using interactive video techniques will be used widely. Lab is included in this course. Basic competency in algebra is assumed.

**1060 Astronomy (2 sh) GE**

This course is intended to be an introductory, algebra-based course in physical science. The course will cover selected topics in astronomy including historical background, the earth-moon system, the solar system, stars and their evolution, environment and groupings of stars, galaxies, and the frontiers of astronomy. Lab is included in this course. Prerequisite: MATH 1010 or higher.

**1070 Climate Dynamics (2 sh) GE**

This course is intended as a survey of the physics of the Earth's climate system. This course focuses on large-scale, long-term variability, ranging from days to millennia, rather than local, short-term weather. Topics include basic fluid dynamics, the energy balance of the Earth, the general circulation of the atmosphere, past and modern climate variability, and climate modeling. Lab is included in this course. Background in trigonometry is assumed.

**1110 College Physics I (4 sh) GE**

This course is a trig-based introductory course in physics for health science majors. The course will cover kinematics, dynamics, circular motion, gravitation, conservation of energy and momentum,

systems in equilibria, rotations, and properties of matter and fluids. Lab is included in this course. Knowledge of trigonometry or permission of instructor is required to register for this course.

**1120 College Physics II (4 sh)**

This course is the second semester of a trigonometry-based introductory course in physics for health science majors. The course will cover thermodynamics, electric fields and potentials, DC circuits, magnetic fields and forces, AC circuits, geometrical optics, physical optics, quantum theory, atomic theory, and nuclear physics. Lab is included in this course. Prerequisite: PHYS 1110.

**1210 Introductory Physics I (4 sh) GE**

This course is the first semester of a calculus-based introductory physics course for science majors. Topics to be covered include kinematics, dynamics, energy and momentum, rotational motion, gravitation, equilibria, properties of materials, fluids, wave motion, sound, and simple harmonic oscillations. Emphasis will be placed on problem solving skills as well as conceptual understanding of the material. Lab is included in this course. Basic knowledge of trigonometry is assumed. Calculus is recommended.

**1220 Introductory Physics II (4 sh)**

This course is the second semester of a calculus-based introductory physics course for science majors. Topics to be covered include thermodynamics, electrical fields and forces, electric potential, DC circuits, magnetic fields and forces, AC circuits, geometrical and physical optics, quantum theory, atomic theory and structure, and nuclear structure, decay, and reactions. Emphasis will be placed on problem solving skills as well as conceptual understanding of the material. Lab is included in this course. Prerequisite: PHYS 1210. Co-requisite: MATH 1510.

**1330 Mechanical Comprehension (2 sh)**

This course is an introduction to a variety of practical, real-world tools used in physics to solve problems and complete projects. In contrast to other courses which focus on the theoretical and analytical aspects of physics, this course covers tools you can use to not only do homework problems but also to tackle real-world engineering and research projects. In this course the focus will be predominately on visual thinking tools. Such topics include drawing and sketching for visualization, imagery and ideation, and basic technical drawing. Coverage may also include basic design and engineering concepts as well as an introduction to CAD.

**1410 Pursuit of Knowledge (2 sh)**

How do we know? How do we decide that a theory is true? What does it take to become convinced? Physics is perceived as a totally analytical and quantitative field. However, the reality is that even at the simplest level there is considerable judgment required in the interpretation of data and the assignment of meaning to theory. This course will include a brief overview of the history and philosophy of Physics, discussion of the methods of doing physics, experimental techniques, and the role of approximation in theory and computation. The emphasis will be placed on the nature of knowledge and the extent to which it is socially constructed. Students will reflect on science ethics, science policy, the role of the scientist in society, and the interface between science and theology.

**1510 Mathematical Methods of Physics (2 sh)**

This course is an introduction to mathematical methods in physics. Topics covered include using spreadsheets (Excel), algebraic languages (Mathematical), and interpreted languages (Python) to solve basic physics problems. Elementary numerical methods and scientific visualization is also covered. Topics of coverage may include: approximation techniques, numerical differentiation and

integration, matrices, complex variables, and solution of transcendental equations.

**2060 Astrophysics (2 sh)**

The main focus of this course will be stellar astrophysics. The course will cover the historical development of astronomy, optics and spectroscopy, telescopes, gravitation, planetary systems and comparative planetology, general relativity, stellar structure, H-R diagrams, stellar evolution and galaxies. Lab is included in this course. This course is intended for science majors interested in astronomy. Basic knowledge of trigonometry is assumed. Calculus is recommended.

**2110 Modern Physics (4 sh)**

This course constitutes a survey of physics since 1900. Topics to be covered include special relativity, blackbody radiation, photoelectric effect, Compton scattering, quantum theory, wave-particle duality, DeBroglie waves, Bohr model of the atom, quantum mechanics and the Schrodinger equation in one dimension, Heisenberg uncertainty principle, quantization in many-electron atoms, statistical physics, lasers, X-ray spectra, molecular structure, solid state physics, nuclear structure, and nuclear reactions. No lab is required. Prerequisite: PHYS 1220.

**2510 Electronics for Scientists (3 sh)**

This course offers a practical introduction to DC and AC circuits, filters, diodes, power supplies, transistors, operational amplifiers, and logic gates. Emphasis will be placed on both the mathematical methods and the rules of thumb used in everyday laboratory settings. Prerequisite: PHYS 2110. Co-requisite: PHYS 2520 (required).

**2520 Electronics Lab (1 sh)**

This course is the lab to accompany PHYS 2510. Students will gain practical experience in building electronic circuits and using electrical measuring devices with an eye toward laboratory application. Co-requisite: PHYS 2510 (required).

**2950 Topics in History and Philosophy of Physics (2 sh)**

This course will cover a topic in the History and Philosophy of Physics. The credit hours will be determined by the choice of topics and the professor teaching the course. Readings in historical methods and philosophy of history will be included as well as instruction in the use of archival materials and oral histories. Proposed topics include: History of Quantum Mechanics and the Influence of the German Romantic Movement, Galileo and the Church, Cold War Science and the Rise of Big Science, Nuclear Security, Medieval Engineering.

**3010 Third-Year Lab (2 sh)**

This course constitutes an introduction to the laboratory techniques employed in physics research. Important experiments in the development of modern physics (since 1900) will be covered as well as more contemporary experiments. There is no accompanying lecture course for this lab. Prerequisite: PHYS 2110.

**3110 Statistical Thermodynamics (4 sh)**

This course seeks to investigate how the unifying concepts of atomic theory can lead to an understanding of the observed behavior of macroscopic systems, how quantities describing the directly measurable properties of such systems are interrelated, and how these quantities can be deduced from a knowledge of atomic characteristics. Topics to be covered include properties of equilibria, heat and temperature, statistical ensembles, probability, specification of the state of a system, thermal interaction, work, internal energy, entropy, Maxwell distribution, equipartition

theorem, applications to an ideal gas, phases, thermal conductivity, and transport of energy. There is no lab for this course. Prerequisite: PHYS 1220.

**3210 Modern Optics (3 sh)**

This course will investigate the electromagnetic basis of light. Topics to be covered include reflection, refraction, and diffraction of light waves, geometrical optics including aberrations, spectra, and introduction to quantum effects. Modern applications of optics including lasers, holography, and nonlinear effects will also be included. Prerequisite: PHYS 2110. Co-requisite: PHYS 3220 (required).

**3220 Optics Lab (1 sh)**

Lab to accompany PHYS 3210. Practical experience in optics including photography, holography, Fourier optics, microwave diffraction, fiber optics. Prerequisite: PHYS 2110. Co-requisite: PHYS 3210.

**3310 Dynamics (4 sh)**

This course presents a detailed account of the classical mechanics of particles, systems of particles, rigid bodies, moving coordinate systems, Lagrange and Hamiltonian formulations, linear oscillators, driven oscillators, nonlinear oscillations, and central force motion. A review of the mathematics of matrices, vectors, tensors, and vector calculus will be included. No lab is required. Prerequisite: PHYS 2110.

**3410 Electromagnetic Fields (4 sh)**

Electric and magnetic phenomena are discussed in terms of the fields of electric charges and currents. The use of Maxwell's equations in the interaction of fields and charges will be emphasized. Extensions to electromagnetic radiation and the interaction with matter will also be covered. No lab is required. Prerequisite: PHYS 2110.

**3510 Quantum Mechanics (4 sh)**

Quantum mechanics deals with the physics of the microscopic realm where classical mechanics fails to explain phenomena such as those seen in lasers and transistors. This course will cover the experimental results that led to and verified quantum mechanics. It will cover the basic topics of quantum mechanics including wave-particle duality, complementarity, the postulates of quantum mechanics, wave packets (their formation and analysis), operators in quantum mechanics, time independent and time dependent Schrodinger Equation and solutions of it for various potentials including the simple harmonic oscillator, Hermitian operators and eigenvalue equations, commutators, uncertainty relations, and conservation laws. Emphasis will be placed on both the mathematical formalism of quantum mechanics and the philosophical implications and alternatives to the theory. There is no lab for this course. Prerequisite: PHYS 2110.

**3910 Atomic Physics (2 sh)**

The methods of quantum mechanics are applied to simple atomic systems. Coverage includes a review of quantum theory, solution of the central force problem using Schrodinger's equation, the one-electron atom, time-independent and time-dependent approximation methods, spin, applications of quantum mechanics to multi-electron atoms, shell model of the atom, perturbation theory, variational method and Hartree and Hartree-Fock theories. There is no lab for this course. Prerequisite: PHYS 2110.

**3920 Solid State Physics (2 sh)**

This course will investigate the properties of condensed matter including crystallographic groups, mechanical properties, thermal

properties, and electrical properties of metals and semiconductors. There is no lab for this course. Prerequisite: PHYS 2110.

**3930 Nuclear and Particle Physics (2 sh)**

This course will investigate the properties of nuclei and elementary particles. Emphasis will be placed upon the structure of nuclei as well as the interactions with nuclei that reveal this structure. Experiments used to obtain information about elementary particles and nuclei will be stressed. Topics to be covered include accelerators and detection systems, interactions of radiation with matter, classification and structure of subatomic particles, symmetries and conservation laws, electromagnetic interactions, weak interactions, hadronic interactions, quarks and Regge poles, nuclear models, and nuclear applications, especially nuclear power. There is no lab for this course. Prerequisite: PHYS 2110.

**3940 General Relativity (2 sh)**

This course will investigate the basic theory of general relativity. Topics to be covered include the principles of special and general relativity including 3+1 space-time, Lorentz transformations, curved space, black holes, and the Einstein field equations. There is no lab for this course. Prerequisite: PHYS 2110.

**3950 Advanced Topics in Contemporary Physics (2-4 sh)**

Various topics in contemporary physics will be discussed. The topics will be determined by the interests of the students. There is no lab for this course. Prerequisite: PHYS 2110.

**4000 Departmental Honors in Physics (1-4 sh)**

Independent study in physics towards a B.S. in Physics with Honors. Students will prepare a written paper which must also be presented orally to an appropriate group. Students must submit a proposal of their intended project for departmental approval prior to enrollment. Student must be a physics major with suitable GPA and have permission of the instructor.

**4010 Fourth-Year Seminar (2 sh)**

This course is intended to help students begin to make the transition from student to professional. The course will have three main goals: 1) to help students examine their goals as they enter graduate school or the private sector; 2) to help students prepare for the departmental comprehensive exam; and 3) to begin to familiarize students with the literature in their field of study.

**4030 Knowledge Reloaded (2 sh)**

In PHYS 1410 students examined how we acquire knowledge and gain understanding about our world. In this course students examine the interface between knowledge and practice. Using their experience and information from their undergraduate courses students will examine the point at which physics research becomes truth. Students will examine how society affects research and how physics becomes part of society. This course will include a brief overview of anthropology and sociology of physics. The social construction of knowledge and the anthropology of the laboratory are examples of topics to be considered. Students will particularly focus on science ethics, security issues and the role of the scientist in forming policy.

**4910 Independent Study in Physics (1-4 sh)**

This course is intended as an opportunity for students to study a topic in physics not included in the regular curriculum. Instructors consent required.

**4930 Research Methods (Experimental) (1-4 sh)**

Experimental research in physics which may be performed off-campus. Students may repeat this course up to a total of 8 semester hours.

**4950 Research Methods (Theoretical) (1-4 sh)**

Theoretical research in physics which may be performed off-campus. Students may repeat this course up to a total of 8 semester hours.

**4970 Internship (1-4 sh)**

Please refer to internship section of the catalog for requirements and guidelines