

Physics

PROFESSORS **Armstrong** (Chancellor Professor) (Chair), **Averett, Carlson** (Class of 1962 Professor), **Carone, Cooke, Delos, Griffioen, Hoatson, Kossler, Krakauer, Manos** (CSX Professor of Applied Science), **McKeown** (Governor's Distinguished CEBAF Professor), **Pennington** (Governor's Distinguished CEBAF Professor), **Perdrisat, Sher, Tracy** (Chancellor Professor), **Vahala, and Zhang**. ASSOCIATE PROFESSORS **Erllich, Lukaszew** (Virginia Micro-Electronic Consortium Associate Professor of Applied Science and Physics), **Nelson** (Cornelia B. Talbot Term Distinguished Associate Professor of Physics), and **Orginos**. ASSISTANT PROFESSORS **Aubin, Deconinck, Detmold, Kordosky, Novikova, Qazilbash, Rossi, and Vahle**. PROFESSORS EMERITUS **Champion** (Chancellor Professor), **Eckhause, Gross, Kane, McKnight, Petzinger, Remler, Schone, Thomas** (Governor's Distinguished CEBAF Professor), **von Baeyer** (Chancellor Professor), **Walecka** (Governor's Distinguished CEBAF Professor), and **Welsh** (Chancellor Professor). TJNAF PROFESSOR **Carlini**. ADJUNCT PROFESSORS **Bosted, Osborne, Reilly, Vanderhaeghen, and Wolf**. ADJUNCT ASSOCIATE PROFESSOR **Danehy**. RESEARCH PROFESSOR **Venkataraman**. RESEARCH ASSOCIATE PROFESSOR **Benner**. RESEARCH ASSISTANT PROFESSOR **Mikhailov**. DIRECTOR OF TEACHING LABS **Hancock**.

Program

Traditionally, many physics undergraduates continue in graduate school in pursuit of Ph.D. degrees. Students who complete a physics major also enter a variety of other fields, including among many others, archaeology, astronomy, biology, mathematics, computer science, high school teaching, law, medicine, environmental sciences, operations research, technical sales, industrial management, engineering and oceanography. Because physicists are scientific generalists, undergraduate work in physics followed by specialization in other areas has become one of the preferred preparations for many activities that are setting new directions in society. The requirements for major in physics are relatively flexible, and are designed to prepare people for either graduate work in physics or for later specialization in other areas.

Information on the program can be obtained through the World Wide Web at the address www.wm.edu/physics.

Requirements for Major

Required Credit Hours: 33 (Honors and the Premed track have additional requirements. See below.)

Major Computing Requirements: The departmental computer proficiency requirement is satisfied through the completion of required course work and, in addition, by demonstrating programming ability. For this purpose, it is strongly recommended that physics concentrators take Physics 256 or Computer Science 141. Otherwise, programming proficiency may be demonstrated through the senior/honors research project or by examination.

Major Writing Requirements: Physics 451-452 or Physics 495-496.

Core Requirements: Students completing a major in physics must take Physics 101, 102, 201, 208, 251, 252, 313, 401, two of the four courses Physics 303, 314, 402, 403, and either the Senior Project (Physics 451-452) or Honors (Physics 495-496) (substitutions for these requirements must be approved by the departmental undergraduate committee and the chair). The requirement of senior project or Honors insures that all majors will engage in independent research during the senior year. Because of the extensive facilities available through the graduate program of the department, the senior projects generally deal with problems at the frontiers of physics. It is only through being actively involved in such pursuits that a student can appreciate the nature of the discipline. Students should also take Physics 256 and 301.

Students who plan to attend graduate school in physics should take all of the courses listed above (including Physics 303, 314, 402 and

403) as well as the junior laboratories (Physics 351-352) and the Undergraduate Seminar (Physics 309). To prepare for some engineering or professional programs it may be appropriate to substitute courses or elect additional courses.

Suitable mathematics courses should also be taken, including Math 111, 112, 213 or 212, 302 and 211.

An alternative concentration for those who are planning to fulfill the requirements for entering medical school consists of Physics 101-102 or 107-108, 201, 208, 251, 252, 313, 401, and the Senior Project (Physics 451-452). A minimum of 30 credits in physics must be completed. In addition, this concentration requires either Chemistry 209/353 or Chemistry 307/353, 308/354, and Biology 203 or 204 for a minimum total of 42 credits.

The minor in physics consists of 20 credits and includes Physics 101, 102, 201 and three other Physics courses, one of which is numbered above 201.

Description of Courses

101-102. General Physics.

(101 and 102 each satisfies GER 2A, Lab) Fall-Spring (4,4) Erllich, Staff. Corequisites: MATH 111-112 recommended.

This course is designed to develop an understanding of the fundamental concepts of physics. Emphasis is placed upon Newtonian mechanics, thermodynamics, electricity and magnetism, and modern physics; current research and applications are discussed. Designed for students who are considering majoring in one of the sciences or mathematics. An honors section of the Physics 102 lecture and honors sections of the laboratories are open to students that have a good preparation for and a strong interest in physics. Students may not obtain credit for both Physics 101 and 107, or for both Physics 102 and 108. Physics 101 is a prerequisite for Physics 102.

105. Great Ideas of Physics.

(GER 2A) Fall (3) Hoatson.

Introduction to the fundamental laws and dominant themes of modern physics, illustrated with selections from the classics of science writing. The course is intellectually sophisticated, but requires no math beyond ratios. (Not appropriate for science and math majors.) Students may not receive credit for Physics 105 if taken after passing Physics 101 or 107.

107-108. Physics for the Life Sciences.

(107 and 108 each satisfies GER 2A, Lab) Fall-Spring (4,4) Sher, Staff.

Covers the fundamental concepts of physics. Newtonian mechanics, wave motion, electric and magnetic fields, simple circuits, and some modern physics are discussed. Designed for students in the life-sciences, including pre-meds. High school science as well as algebra and trigonometry are assumed. Students may not obtain credit for both Physics 101 and 107, or for both Physics 102 and 108. Physics 107 is a prerequisite for Physics 108.

109. Practical Physics.

(GER 2A) Spring (3) Hancock.

Bicycles, guitars, cameras and other ordinary objects are studied and explained to obtain an appreciation of the underlying laws of nature. Mechanics, wave motion, optics, acoustics, thermodynamics and some electromagnetism and nuclear/particle physics are discussed and demonstrated by understanding the functioning of objects of everyday experience. The required mathematics is limited to algebra. The associated laboratory is strongly encouraged but not required. Students may not receive credit for Physics 109 if taken after passing Physics 101 or 107.

110. Experimental Practical Physics.

(Lab) Spring (1) Hancock. Corequisite: PHYS 109.

A series of experiments employing common objects of general, everyday experience is undertaken with the goal of understanding both the scientific method of measurement and the laws of nature. Student-generated projects will be encouraged.

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121. Physics of Music.

(GER 2A) Fall (3) (Not offered 2011)

Basic concepts of physics, particularly acoustics, needed for an understanding of the properties of sound and music. The course will be in the form of a workshop and students will participate in the performance of experiments which illustrate the ideas.

150/150W. Freshman Seminar.

Fall or Spring (3-4) Staff.

A course that introduces freshmen to topics in the study of Physics. 150W satisfies the freshman writing requirement.

175. Development of Physics and Cosmology.

(GER 2A) Fall and Spring (3,3) Staff. (Not offered 2011).

The evolution of ideas about the structure and nature of the universe from the time of the Renaissance to the present. The role of modern physics in understanding the history of the universe is stressed.

176. Introductory Astronomy.

(GER 2A) Fall and Spring (3,3) Vahle.

Descriptive study of the solar system; theories of the origin of the solar system. Star classification; descriptive studies of star clusters and galaxies. Recent developments such as quasars, pulsars, neutrino astronomy and radio astronomy. Current theories of the origin of the universe. Course includes observation of the sky.

177. Astronomy Laboratory.

(Lab) Fall and Spring (1,1) Hancock. Prerequisite or Corequisite: PHYS 176.

A series of experiments is undertaken with the goal of understanding both the scientific method of measurement and the laws of nature as they apply to astronomy. Two and one-half laboratory hours.

201. Modern Physics.

Fall (3) Novikova. Prerequisites: PHYS 101, PHYS 102 or PHYS 107, PHYS 108.

20th-century developments in physics. Relativity theory; the nature of space and time, the paradox of the twins, the equivalence of mass and energy. Introductory quantum theory; the particle nature of light, the wave nature of electrons, atomic and molecular structure, the structure of the nucleus and the discovery of new particles. This course is appropriate for all those majoring in science or mathematics.

208. Classical Mechanics of Particles and Waves I.

Spring (4) Cooke.

Newton's laws, the simple harmonic oscillator, nonlinear oscillations and chaos, variational methods, Lagrangian and Hamiltonian mechanics. Overview of relevant mathematical methods.

251. Experimental Atomic Physics.

Fall (2) Kordosky. Corequisite: PHYS 201.

Fundamental experiments in atomic physics. Modern scientific methods and instruments are used in such classic experiments as the measurement of the speed of light, the Millikan oil drop experiment, the photo-electric effect and optical spectroscopy.

252. Electronics I.

Spring (2) Aubin. Prerequisite: PHYS 102 or PHYS 108.

Introduction to analog electronics. Theory, design, and application of circuits using passive and active components.

256. Practical Computing for Scientists.

Fall (3) Mikhailov. Prerequisite: MATH 112.

This course will focus on breaking scientific problems into algorithmic pieces that can be solved using computational methods in MATLAB. Root finding, linear and non-linear equations, numerical modeling, optimization, random processes, graphical data presentation and fitting, scientific documentation preparation.

301. Introduction to Mathematical Physics.

Spring (3) Deconinck. Prerequisite: Math 212 or 213

Vector analysis, complex variables, matrices, series solutions of differential equations, orthogonal functions and partial differential equations.

303. Classical Mechanics of Particles and Waves II.

Fall (3) Perdrisat. Prerequisite: PHYS 208.

Central force motion, scattering, systems of particles, coupled oscillations and normal modes, rigid body rotation, inertia tensor, continuum mechanics and wave motion, special relativity.

309. Undergraduate Seminar.

Spring (1) Vahala.

Discussion of contemporary research in physics. Faculty members give survey talks during the first part of the semester. During the second part, students give talks based on their reading and research. May be repeated for credit.

313-314. Introduction to Quantum Physics.

Fall-Spring (3,3) Averett. Prerequisites: PHYS 201, PHYS 208.

Introduction to non-relativistic quantum mechanics, emphasizing basic principles with illustrations from atomic, solid state and nuclear physics.

351. Electronics II.

Fall (2) Hancock.

Design and construction of digital circuits. Computer-based control of digital devices used in experimental research.

352. Experimental Modern Physics.

Spring (2) Perdrisat.

Experiments in atomic, nuclear, solid state and elementary particle physics.

401-402. Electricity and Magnetism.

Spring and Fall (3,3) Aubin. Prerequisite: PHYS 208.

Development of the theory of electricity and magnetism from fundamental principles. Maxwell's equations, electromagnetic waves and radiation.

403. Statistical Mechanics and Thermodynamics.

Fall (3) Carone. Prerequisite: PHYS 201.

Introduction to quantum statistical mechanics and thermal physics. Definitions of accessible quantum states, entropy, free energy, temperature and partition function for noninteracting systems. Derivation and interpretation of the physical and thermodynamic properties of classical and quantum gases, solids, thermal radiation and diffusive equilibrium.

404. Quantum Physics: Research Applications.

Spring (3) Staff. Prerequisites: PHYS 313, PHYS 314.

Applications of quantum physics to modern research topics. The course will focus on areas (to be determined by the instructor) such as: electronic and magnetic properties of solids, atomic and optical physics, or nuclear and particle physics. May be repeated for credit when the instructor determines that there will not be a duplication of material.

451-452. Physics Research.

Fall and Spring (1-3,1-3) Krakauer.

Independent study including bibliographic and experimental or theoretical research and a research paper. The student will be required to submit a preliminary draft of the research paper during the first semester and will be expected to work closely with an advisor both in the actual research and in preparation of an acceptable report. If satisfactorily completed, this course will meet the departmental writing requirement.

476. Modern Astrophysics.

Spring (3) Staff. Prerequisites: PHYS 303, PHYS 313. Corequisite: PHYS 401. (Not offered in 2011)

An introduction of modern astrophysics. Topics may include stellar characteristics and evolution, galactic structure, cosmology, general relativity and the tools and techniques of astronomy and astrophysics.

***481. Topics in Physics.**

Fall (1-3) Staff. Prerequisite: Consent of instructor.

May be repeated for credit when the instructor determines that there will not be a duplication of material.

***482. Topics in Physics.**

Spring (3) Staff. Prerequisite: Consent of instructor.

May be repeated for credit when the instructor determines that there will not be a duplication of material.

†*495-496. Honors.

Fall, Spring (3,3) Krakauer.

Students admitted to Honors study in physics will be enrolled in this course during both semesters of their senior year. Each candidate will be responsible for (a) reading and discussion of a selected list of books in some specific area of the literature of physics; (b) the preparation and presentation by April 15 of an Honors essay based on the student's own research, or part of a major research project; (c) satisfactory completion of a comprehensive oral examination on essay and related topics. If successfully completed this course will satisfy the College writing requirement. In addition to the major course requirements, the department requirements for Honors specify Physics 303 and 351, as well as either Physics 314 or 402. In applying for Honors, students must submit a proposal to the undergraduate committee during the semester preceding enrollment. For College provisions governing the Admission to Honors, see catalog section titled Honors and Special Programs.

Graduate Program

The department offers the degrees of Master of Science and Doctor of Philosophy. Degree requirements and a full description of graduate courses in physics can be obtained through the World Wide Web at www.wm.edu/physics or you may request application forms by e-mail at grad@physics.wm.edu or by writing to the Chair of the Graduate Admission Committee in Physics.