‘Catalog-ready copy”

Program of Concentration in Physics

The departmental major provides a thorough grounding in the core areas of physics. It is suitable either as preparation for careers in science and engineering or as a springboard for applying technical knowledge in such fields as business, medicine, law, public policy, and education. The major in the Department of Physics and Astronomy consists of 31-32 credit hours of course work, distributed as below. Students considering majoring in physics are strongly encouraged to consult with the Director of Undergraduate Studies before registering for classes.

1. Core courses covering the major subdisciplines of physics—students must complete four of the following (12 credit hours): Modern Physics and the Quantum World (2255); Classical Mechanics (2275); Electricity, Magnetism, and Electrodynamics I (2290); Statistical Physics (3200); Quantum Mechanics I (3651).

2. Laboratory work. Students may not use AP credit to satisfy any portion of the laboratory sequence requirement (3-4 credit hours):
   a) Laboratory Principles I (1912L), Laboratory Principles II (2255L), and Introduction to Experimental Research (2953L); or
   b) 1501L or 1601L, 1502L or 1602L, 2255L, and 2953L if the student has entered the major by taking the introductory physics course sequence 1501 or 1601, 1501L or 1601L, 1502 or 1602, and 1502L or 1602L. Students considering majoring in physics who begin in 1501 or 1601 and 1501L or 1601L in the fall semester are encouraged to take the combination 1502 + 1912L or 1602 + 1912L in the spring semester.

3. Electives (9 credit hours): Pedagogical course work in physics and/or astronomy; research hours (3850, 3851, 4998) do not count toward this requirement. The course electives may be taken from any 2000-level or higher PHYS or ASTR courses not used to satisfy any other requirement of the major. Other courses may count as electives, such as courses offered by the engineering school (or other departments and schools) that are particularly relevant, such as a course in environmental studies, health physics, optics, or materials science. Such exceptions must be approved by the Director of Undergraduate Studies.

4. Capstone (7 credit hours): Computational Physics (3790), three credit hours of research (3850, 3851, or 4998) taken across one or more semesters, and the Seminar in Presenting Physics Research (3600). Physics-related research done in other departments and programs, supervised by Vanderbilt faculty and pre-approved by the Director of Undergraduate Studies, is also permitted in satisfaction of the research requirement.

   Immersion Experience: An enhanced version of the Capstone Program, in which a student earns credit for 3851, 3852, or 4998 (but not 3850), and then completes an additional semester of 3600, will enable a student majoring in Physics to complete their Immersion Experience within the disciplines of either Physics or Astronomy.

   Computer Science course work: All 2000-level and higher PHYS courses assume students have working skills in programming. These skills may be learned outside of a regular course, but should be equivalent to that taught in CS 1101: Programming and Problem Solving. Students who do not already have these skills are strongly advised to take this class in the first semester, prior to beginning the three-semester laboratory sequence in the second semester. In addition, the following Computer Science and/or Scientific Computing courses are strongly recommended for all physics majors: Program Design and Data Structures (CS 2201) or Program Design and Data Structures for Scientific Computing (CS 2204); Algorithms (CS 3250) or Scientific Computing Toolbox (SC 3250); and High Performance Computing (SC 3260). Physics majors pursuing a second major or minor in Computer Science should take CS 2201; physics majors pursuing a minor in Scientific Computing should take CS 2204.

   Mathematics course work: All physics majors are expected to have high-level skills in mathematics in order to be successful in PHYS classes and to prepare for graduate work. MATH courses are not formally required for the
major in physics; however, most physics courses identify MATH prerequisite or co-requisite courses in order to indicate the mathematical skill-level assumed for that class. Multivariable calculus is a co-requisite for 2255 and a prerequisite for all other 2000-level or higher PHYS courses. Physics majors are expected to develop a working knowledge of single-variable calculus, multivariable calculus, and ordinary differential equations. The following courses are those strongly recommended for physics majors:

1. Accelerated Calculus I (1300) and Accelerated Calculus II (1301);
2. Multivariable Calculus (2300) or Multivariable Calculus and Linear Algebra (2500 and 2501); and
3. Methods of Ordinary Differential Equations (2420) or Ordinary Differential Equations (2610).

In addition, for Physics majors considering post-graduate work in Physics or in a related field, the following PHYS and MATH courses are strongly recommended as electives:

1. Electricity, Magnetism, and Electrodynamics II (PHYS 2291), Quantum Mechanics II (PHYS 3652), Mathematical Methods of Physics (PHYS 4005); and
2. Methods of Linear Algebra (MATH 2410) or Linear Algebra (MATH 2600); Introduction to Probability and Mathematical Statistics (MATH 2820); Statistics Laboratory (MATH 2820L); Complex Variables (MATH 3110); Introduction to Partial Differential Equations (MATH 3120); Fourier Analysis (MATH 3130); and Advanced Engineering Mathematics (MATH 3600).

**Licensure for Teaching**

Candidates for teacher licensure in physics at the secondary level may qualify by taking the basic physics major together with the requisite education courses described in the chapter on Licensure for Teaching in the Peabody College section of the catalog.

**Honors Program**

The Honors program in the Department of Physics and Astronomy is designed to allow a student to engage in advanced research under the guidance of a faculty member, usually in an area related to an ongoing research program in the department. A student majoring in Physics interested in Honors (Honors in Physics or Honors in Astronomy) will work with a faculty mentor to develop an appropriate research project that will be conducted under the guidance of that faculty member. The Honors project must have a substantial grounding in physics or astronomy, but may be conducted under the direct supervision of any faculty member in any department at Vanderbilt. To be admitted to the Honors program, a student must submit a two-page research proposal describing the plans for their Honors project, which must be approved by the director of the departmental Honors program. In addition, a student must have completed 2953L, either 2255 or 3651, and meet the minimum GPA requirements for Honors programs of the College of Arts & Science.

To graduate with Honors, a student must

- Have at least a 3.300 cumulative GPA and a 3.300 GPA in courses that count toward the major.
- Earn a minimum of six credit hours in research classes (3850, 3851, 4998), leading to an honors thesis, with at least two of these credit hours earned in 4998. A student who earns credit for 3852 may satisfy this portion of the requirement with three credit hours of research earned at Vanderbilt, including at least two of these credit hours in 4998.
- Write a senior thesis of high merit, as evaluated by the student’s Honors Examination Committee; the thesis may be submitted either in the fall or spring semester of the senior year.
- Demonstrate high attainment on an oral honors examination in which they present and defend their work to the student’s Honors Examination Committee; the oral examination may take place either in the fall or spring semester of the senior year.

**Departmental Minors**

The physics and astronomy minors are suitable for students who wish to supplement a related discipline or simply have a general interest in the field. Research is not a requirement for either minor.

**Minor in Physics**

The minor requires a minimum of 19 credit hours of course work, distributed as follows:
Any first-semester physics class (1501, 1601, 1911, 2051) 3-4
Any first-semester physics laboratory (1501L, 1601L, 1912L, 2052) 1
Any second-semester physics class (1502, 1602, 1912, 2053) 3-4
Any second-semester physics laboratory (1502L, 1602L, 2255L, 2054) 1
PHYS 2255 or 3651 3
Six credit hours of electives. These may be selected from any 2000-level or higher-level PHYS courses not used to satisfy the above requirements or from three credit hour non-PHYS courses, the latter if approved by the Director of Undergraduate Studies, and may include up to three credit hours of research (3850, 3851, 4998).

Total credit hours: 17-19

Minor in Astronomy

The minor requires a minimum of 16 credit hours of course work, distributed as follows:

ASTR 1010 and either 1010L or 1020L; or 1210 4
ASTR 2110 3
ASTR 3000 3
Two other astronomy courses, one of which may be a three credit hour one semester research project (3850, 3851, 4998). Note that only Physics majors pursuing Honors in Astronomy are eligible to enroll in 4998. 6

Total credit hours: 16