

# Physics

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Physics is the most fundamental of all of the sciences; its goal is nothing less than to figure out the most basic laws which govern the universe. Because of this, the study of physics offers deep insights into many disciplines: knowledge of physics is a foundation for understanding the fundamentals of chemistry, biology and geology. It also offers insight into other aspects of our modern world. For example, two allied problems of today are the energy crisis and the issue of global climate change. It is impossible to understand either of these issues without some knowledge of physics.

The goals of the department are to a) teach our students a basic understanding of the laws of physics and their applications; b) teach them to understand the structure of the Universe around us as generated by those laws; and c) provide our majors with an introduction to research methods in physics (both experimental and theoretical.)

To this end we offer a rigorous major program in physics with concentrations in two areas: fundamental and applied physics. Both programs are equally rigorous; the fundamental physics track is a standard undergraduate program primarily meant for students who are interested in pursuing a graduate career in physics, while the applied physics track is meant for students interested in future work and/or graduate study in the applied sciences or technology (i.e., in disciplines such as applied physics, engineering, geology or geophysics, biophysics and bioengineering, etc.).

We also offer a physics minor designed for students majoring in mathematics, chemistry or biology, and several undergraduate courses designed for the general student, including two courses in astronomy. Undergraduates can also take part in research with faculty members, both as part of the St. Mary's Project and also in a summer research program at the nearby Patuxent River Naval Air Station. Our students have also participated in research programs at NIST, the NASA-Goddard Spaceflight Center and the Super Kamiokande Neutrino detector in Japan.

## Learning Outcomes

- Integrate the many laws of physics to explain the phenomena of a specific real-world problem
- Produce new knowledge by application of appropriate physical models to real-world situations
- Construct clear and concise written explanations and oral presentations of their work at a level appropriate for the audience
- Build a useful model of a real-world situation
- Construct solutions to real-world problems using the laws of physics
- Locate relevant information sources for use
- Seek new and unexpected situations to analyze and understand

## Degree Requirements for the Major

### Degree Requirements for the Major - Concentration in Fundamental Physics

To earn a bachelor of science degree with a major in physics, concentration in fundamental physics, a student must satisfy the following minimum requirements:

### General College Requirements

General College Requirements (see Curriculum section), including the following requirements to satisfy the major

### Required Courses

#### Physics Core Courses (32 credit hours)

- PHYS 151: Fundamentals of Physics I (recommended) or PHYS 141 General Physics I
- PHYS 152: Fundamentals of Physics II (recommended) or PHYS 142 General Physics II
- PHYS 251: Fundamentals of Physics III
- PHYS 312: Advanced Physics Laboratory
- PHYS 342: Mechanics
- PHYS 351: Electricity & Magnetism
- PHYS 462: Quantum Mechanics
- PHYS 473: Statistical Mechanics

#### Cognate Courses (16 credit hours)

- MATH 151: Calculus I

- MATH 152: Calculus II
  - MATH 255: Vector Calculus
  - MATH 256: Linear Algebra
- Elective Courses (four credit hours selected from the following list of courses)**

- PHYS 281: Mathematical Methods of Physics
  - PHYS 311: Electronics
  - PHYS 382: Optics
  - PHYS 391: Astrophysics
  - PHYS392: Cosmology
  - PHYS 475: Topics in Applied Physics I
  - PHYS 490: Senior Seminar
  - MATH 312: Differential Equations
  - CHEM 451: Physical Chemistry
  - PHYS 399: Independent Study (as approved by the physics faculty) or PHYS 499
- Students majoring in either concentration of the Physics major may also minor in Astrophysics, but cannot use PHYS 391: Astrophysics or PHYS 392: Cosmology to satisfy the upper-level elective requirements of the Physics major if they do so.

## St. Mary's Project

Every physics major with concentration in fundamental physics must complete a St. Mary's Project. This project may be in physics or in another major discipline or a study area. The guidelines established in the selected area apply. The project must be proposed to a mentor and to the chair of the Department of Physics at least three weeks before the last day of classes of the second semester of the student's junior year, and it must be approved by the mentor and the department chair.

## Minimum Grade and GPA Requirements

Students must earn a grade of C- or better in all courses listed in items 2-3 above, and maintain an overall GPA of 2.0 or better in these required courses.

## Sequence of Study

The following model is suggested as a sequence of study that satisfies the above requirements:

- First Year:

Core Curriculum requirements, MATH 151, MATH 152, PHYS 151, PHYS 152

- **Sophomore Year:**

Core Curriculum requirements, MATH 255, MATH 256, PHYS 251, PHYS 342

- **Junior Year:**

Core Curriculum requirements, PHYS 312, PHYS 351, PHYS 462, and elective courses

- **Senior Year:**

Mary's Project, Core Curriculum requirements, PHYS 473, and elective courses

### **Degree Requirements for the Major - Concentration in Applied Physics**

To earn a bachelor of science degree with a major in physics, concentration in applied physics, a student must satisfy the following minimum requirements:

## **General College Requirements**

General College Requirements (see "Curriculum" section), including the following requirements to satisfy the major

## **Required Courses**

### **Physics Core Courses (32 credit hours)**

- PHYS 151: Fundamentals of Physics I (recommended) or PHYS 141 General Physics I
- PHYS 152: Fundamentals of Physics II (recommended) or PHYS 142 General Physics II
- PHYS 251: Fundamentals of Physics III
- CHEM 106: General Chemistry 2 or COSC 120 Introduction to Computer Science
- PHYS 311: Electronics
- PHYS 312: Advanced Physics Laboratory
- PHYS 351: Electricity & Magnetism
- PHYS 462: Quantum Mechanics

### **Cognate Courses (16 credit hours)**

- MATH 151: Calculus I
- MATH 152: Calculus II
- MATH 255: Vector Calculus
- MATH 256: Linear Algebra

### **Elective Courses (four credit hours selected from the following list of courses)**

- PHYS 342: Mechanics
- PHYS 382: Optics
- PHYS 391: Astrophysics (Can only be used for the major or minor, not both)

- PHYS392: Cosmology (Can only be used for the major or minor, not both)
- PHYS 473: Statistical Mechanics
- PHYS 490: Senior Seminar
- CHEM 451: Physical Chemistry
- COSC 301: Software Engineering 1
- MATH 312: Differential Equations
- MATH 411: Partial Differential Equations

## Senior Seminar in Applied Physics

Every physics major with concentration in applied physics must successfully complete two semesters of the senior seminar in Applied Physics, PHYS 475: Topics in Applied Physics, with two separate topics. Topics will typically be different in fall and spring semester. Majors with this concentration do not need to do a St. Mary's Project, but may do so if they wish. If they choose to do so, requirements for the St. Mary's Project are the same as for students with a concentration in fundamental physics.

## Research Experience

Research is integral to the practice of physics. Every physics major with concentration in applied physics must successfully complete a research experience in one of the following three ways:

- St. Mary's Project. This project may be in physics or in another major discipline or a study area. The guidelines established in the selected area apply. The project must be proposed to a mentor and to the chair of the Department of Physics at least three weeks before the last day of classes of the second semester of the student's junior year, and it must be approved by the mentor and the department chair.
- Directed Research in Physics at an upper level. To use Directed Research to satisfy the research requirement for the concentration in applied physics, students must successfully complete a total of four credits of upper-level Directed Research in Physics (PHYS 397 or 497). Concurrent with the final credit of Directed Research, the student must also register for PHYS 350 and complete its presentation requirement.
- Other research experience. Students with a concentration in applied physics may satisfy the research requirement with another approved research experience, such as a Research Experience for Undergraduates or a research assistantship at another institution, so long as

the research experience is in physics or a related discipline and it occupies at least 160 hours. Concurrent with the research experience, the student must also register for PHYS 350 and complete its presentation requirement.

## Minimum Grade and GPA Requirements

Students must earn a grade of C- or better in all courses listed in items 2-3 above, and maintain an overall GPA of 2.0 or better in these required courses.

## Degree Requirements for the Minor

Required courses: All students in the minor must take the 12-credit introductory general physics sequence:

- PHYS 151: Fundamentals of Physics I (recommended) or PHYS 141 General Physics I
- PHYS 152: Fundamentals of Physics II (recommended) or PHYS 142 General Physics II
- PHYS 251: Fundamentals of Physics III

Students must take eight credits (two courses) from among any of the courses listed below:

- PHYS 281: Mathematical Methods in Physics
- PHYS 311: Electronics or PHYS 312: Advanced Laboratory
- PHYS 342: Mechanics
- PHYS 351: Electricity and Magnetism
- PHYS 382: Optics
- PHYS 391: Astrophysics
- PHYS392: Cosmology
- PHYS 462: Quantum Mechanics
- PHYS 473: Statistical Mechanics
- PHYS 475: Topics in Applied Physics I (may be taken more than once for credit under different topics)
- PHYS 490: Topics in Physics

Students majoring in either concentration of the Physics major may also minor in Astrophysics, but cannot use PHYS 391: Astrophysics or PHYS 392: Cosmology to satisfy the upper-level elective requirements of the Physics major if they do so.

If a student in the minor takes both PHYS 311 and PHYS 312, only one of these courses will

count towards credit in the minor.

Students should note that most upper-level physics courses have prerequisite or co-requisite mathematics courses which also must be taken. Students should also note that not all of the upper-level courses listed here will be offered every year. Chemistry majors who pursue a physics minor are strongly encouraged to take PHYS 462 (Quantum Mechanics) or PHYS 473 (Statistical Mechanics) as elective courses.

Students must maintain a minimum 2.0 GPA within the minor.

## Degree Requirements for the Astrophysics Minor

Astrophysics is the application of physics to the large-scale structure of the universe: the birth and death of stars, the formation of galaxies, and the origin and fate of the Universe itself.

Required courses (20 credit hours)

Required courses: All students in the minor must take the 12-credit introductory general physics sequence:

- PHYS 151: Fundamentals of Physics I (recommended) or PHYS 141 General Physics I
- PHYS 152: Fundamentals of Physics II (recommended) or PHYS 142 General Physics II
- PHYS 251: Fundamentals of Physics III

In addition, students must take the following two upper-level courses:

- PHYS391: Astrophysics
- PHYS392: Cosmology

Students majoring in either concentration of the Physics major may also minor in Astrophysics, but cannot use PHYS 391: Astrophysics or PHYS 392: Cosmology to satisfy the upper-level elective requirements of the Physics major if they do so.

Elective Courses (4 credit hours)

Students must take one of the two Astronomy courses:

- ASTR154: Solar System Astronomy
- ASTR155: Stellar Astronomy and Cosmology

Students should note that most upper-level physics courses have prerequisite or co-requisite mathematics courses that also must be taken. Students should also note that not all of the upper-level courses listed here will be offered every year.

Minimum Grade and GPA Requirements

Students must maintain a minimum 2.0 GPA within the minor.

#### Physics Majors

Students majoring in either concentration of the Physics major may also minor in Astrophysics, but cannot use PHYS391: Astrophysics or PHYS392: Cosmology to satisfy the upper-level elective requirements of the Physics major if they do so.

#### Learning outcomes

At the successful completion of the Astrophysics Minor, students will be able to integrate concepts from astronomy and cosmology to understand the evolution of stars, galaxies, and the universe.

## Faculty

Charles Adler, Erin De Pree, Joshua Grossman (department chair), Michelle Milne, Katsunori Mita