PHYSICS (BS AND BA OPTIONS AVAILABLE)

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Introduction

The Canisius College Physics major provides a strong background in the scientific skills of analysis and experimentation and gives students a broad choice of career opportunities. The Physics major is a preparation for further study in graduate physics and related areas such as oceanography, geophysics, patent law, medicine, engineering and astronomy and entry into research and development employment. The specific goal for majors is a thorough knowledge of basic physical science and the mathematical and experimental application of this basis to the study of natural phenomena. Other offerings are intended to give non-majors an appreciation of the relation between science and the world within which they live.

Our department offers a number of degree tracks to match with the students’ interests and career goals.

- Bachelor’s of Science (BS) in Physics (p. 2) - curriculum is designed to prepare the student for graduate school in physics, engineering, or a related scientific field.
- Bachelor’s of Arts (BA) in Physics (p. 3) - curriculum is designed to cover the major topics in the Physics BS program with fewer requirements. This degree is optimal for students interested in a different career path such as teaching in secondary education, law, medicine, journalism, etc. The Physics BA is not meant as preparation for graduate school in physics or engineering. Curriculum easily allows for double majoring.
- Dual Degree Engineering Program (3+2 Physics/Engineering) ([http://catalog.canisius.edu/undergraduate/college-arts-sciences/physics/pre-engineering-programs/3-2-program](http://catalog.canisius.edu/undergraduate/college-arts-sciences/physics/pre-engineering-programs/3-2-program)) - the student spends 3 years studying Physics at Canisius College and the next 2 years in the Engineering Program at the University at Buffalo or Pennsylvania State University at Erie. At the end of the 5 years, the student will receive a Physics degree from Canisius College and a Engineering degree from the other school.
- Pre-engineering Program (2+2) ([http://catalog.canisius.edu/undergraduate/college-arts-sciences/physics/pre-engineering-programs/2-2-program](http://catalog.canisius.edu/undergraduate/college-arts-sciences/physics/pre-engineering-programs/2-2-program)) - the student works their first 2 years at Canisius College taking the introductory physics, mathematics, and engineering courses. After transferring to the engineering school of their choice, they complete their engineering degree after the third and fourth years. This is a transfer program, and they are not awarded a degree from Canisius College.
- Engineering Program at the University at Buffalo or Pennsylvania State University at Erie. At the end of the 5 years, the student will receive a Physics degree from Canisius College and an Engineering degree at University at Buffalo (UB) or Pennsylvania State University at Erie. For those interested in Physics teaching, a Physics Education program is offered in conjunction with the education department. The Physics Club offers opportunities for social activities, technical tours, lectures and other activities.

Advisement

All students should have an advisor in the major and should contact the department directly to have an advisor assigned if they do not already have one. Meetings with academic advisors are required prior to students receiving their PIN for course registration each semester. All majors should work closely with their advisor in discussing career expectations, choosing their major electives, developing their entire academic program and planning their co-curricular or supplemental academic experiences.

Advising is particularly important for Physics majors due to the highly structured curriculum and numerous course prerequisites.

Major Experiences

Physics majors use modern physics equipment like a 3D printer, lasers, X-ray florescence, a multi-channel nuclear spectrometer, various radiation detectors, and an X-ray spectrometer. They have access to departmental computers. In addition, a large supply of other equipment is available for students to use as early as their first semester. In addition to the standard physics major, students may also wish to consider the Dual Degree Engineering Program, which offers students the option of completing a Physics Degree at Canisius and an Engineering degree at University at Buffalo (UB) or Pennsylvania State University at Erie. For those interested in Physics teaching, a Physics Education program is offered in conjunction with the education department. The Physics Club offers opportunities for social activities, technical tours, lectures and other activities.

The faculty in the department are active in research in the fields of experimental nuclear physics, robotics, physics education, and computational science. Students frequently join with a professor on his or her respective projects and perform a variety of research tasks. Students gain skills in large-scale computation, data analysis, electronics, and detector assembly and testing. In many cases, the research is interdisciplinary with the student working with a physics professor and a faculty member in the Mathematics ([http://catalog.canisius.edu/undergraduate/college-arts-sciences/mathematics](http://catalog.canisius.edu/undergraduate/college-arts-sciences/mathematics)), Computer Science ([http://catalog.canisius.edu/undergraduate/college-arts-sciences/computer-science](http://catalog.canisius.edu/undergraduate/college-arts-sciences/computer-science)), and Digital Media Arts ([http://catalog.canisius.edu/undergraduate/college-arts-sciences/digital-media](http://catalog.canisius.edu/undergraduate/college-arts-sciences/digital-media)) Departments. Routinely, students present posters at local, statewide, and national conferences. Past students have conducting research through the National Science Foundation’s Research Experience for Undergraduates at institutions such as University of Rochester, University of Notre Dame, and Baylor University.

Double Majors

Students who wish to expand their educational opportunities may decide to declare a double major. The decision may be based on career goals or planned graduate studies. Before a student declares a double major, it is important to meet with the appropriate academic departments for advisement. Some double major combinations can be completed within the minimum 120 credit hour degree requirement, but in some cases additional course work may be required. In order to declare a double major, the student must complete the appropriate double major request form and get the signature of each department chairperson and the appropriate associate dean. Please note that students will receive only one degree, regardless of the number of majors they complete.

Double majors in Physics BS (p. 2) and Computer Science ([http://catalog.canisius.edu/undergraduate/college-arts-sciences/](http://catalog.canisius.edu/undergraduate/college-arts-sciences/)).
computer science), or Physics BS (p. 2) and Mathematics (http://catalog.canisius.edu/undergraduate/college-arts-sciences/mathematics-statistics) are common and offer interesting career options. The Physics BA (p. 3) can be combined with almost any other program at the college.

**Minors in Other Disciplines**

Minors provide students the opportunity to pursue additional interests but generally do not require as many courses as a major. Minors generally range from five to eight required courses. The minors page (http://catalog.canisius.edu/undergraduate/minors) provides a complete list of minors and provides links to each minor. Some majors and minors can be completed within the minimum 120 credit hour degree requirement, but in some cases additional coursework may be required. Students must complete the appropriate minor request form.

The Physics minor is particularly popular when combined with majors in Chemistry (http://catalog.canisius.edu/undergraduate/college-arts-sciences/chemistry), Mathematics (http://catalog.canisius.edu/undergraduate/college-arts-sciences/mathematics-statistics), or Computer Science (http://catalog.canisius.edu/undergraduate/college-arts-sciences/computer-science).

**Curriculum**

**Curriculum Requirements for a BS in Physics**

**An Ignatian Foundation**

All undergraduate students must complete either the Canisius Core Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/core-curriculum) or the All-College Honors Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/all-college-honors-program). Many schools refer to their college-wide undergraduate requirements as ‘general education’ requirements. We believe that the core curriculum and the honors curriculum are more than a series of required classes; they provide the basis for a Jesuit education both with content and with required knowledge and skills attributes that are central to our mission.

**Free Electives**

Students may graduate with more but not less than 120 credit hours. Free electives are courses in addition to the Canisius Core Curriculum or All-College Honors Curriculum and major requirements sufficient to reach the minimum of 120 credit hours required for graduation.

**Major Requirements**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 111</td>
<td>Introduction to Programming and Introduction to Programming Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 111L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHY 223</td>
<td>General Physics for Physical Science Majors I and General Physics for Physical Science Majors I Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 223L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHY 224</td>
<td>General Physics for Physical Science Majors II and General Physics for Physical Science Majors II Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 224L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHY 225</td>
<td>General Physics for Physical Science Majors III and General Physics for Physical Science Majors III Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 225L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHY 226</td>
<td>Basic Electronics and Basic Electronics Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 226L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHY 330</td>
<td>Electrodynamics I</td>
<td>3</td>
</tr>
<tr>
<td>PHY 331</td>
<td>Electrodynamics II</td>
<td>3</td>
</tr>
</tbody>
</table>

**Major Electives**

Computer Science (http://catalog.canisius.edu/undergraduate/college-arts-sciences/computer-science) and Mathematics (http://catalog.canisius.edu/undergraduate/college-arts-sciences/mathematics-statistics) courses are highly recommended, particularly linear algebra.

**Difference with the Physics BA Degree**

The Physics BS degree program is designed to prepare the students for graduate school in Physics, Engineering, or a related scientific field. Therefore, it has more major course requirements than the Physics BA degree. The first 2 years of both programs are identical. The Physics BS degree requires more major courses in the third and fourth years in order to provide more depth or knowledge and experience. The student is advised to consult the BS and BA Roadmaps for the specific differences.

**Additional Course Considerations**

Courses in the Junior and Senior years rotate on a two year basis. Please consult your advisor about which set of courses is available in any given year.

**Note:** Course availability may be a factor in determining time to degree completion for transfer students. Discussion with department faculty is highly recommended for transfer students.

**Roadmap**

**Recommended Semester Schedule for Major Course Requirements for a BS in Physics**

<table>
<thead>
<tr>
<th>Freshman</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td>MAT 111</td>
<td>MAT 112</td>
<td></td>
</tr>
<tr>
<td>CHM 111 &amp; 111L</td>
<td></td>
<td>Science Elective</td>
</tr>
<tr>
<td>Sophomore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td>MAT 211</td>
<td></td>
<td>MAT 222</td>
</tr>
</tbody>
</table>

**Notes:**

1. Science Elective should be chosen from BIO 111, CHM 112, CSC 112, MAT 219 or MAT 351.
minimum of 120 credit hours required for graduation. College Honors Curriculum and major requirements sufficient to reach the electives are courses in addition to the Canisius Core Curriculum or All-Students may graduate with more but not less than 120 credit hours. Free Electives skills attributes that are central to our mission. for a Jesuit education both with content and with required knowledge and curriculum are more than a series of required classes; they provide the basis requirements. We believe that the core curriculum and the honors curriculum are more than a series of required classes; they provide the basis for their college-wide undergraduate requirements as "general education" requirements. We believe that the core curriculum and the honors curriculum are more than a series of required classes; they provide the basis for a Jesuit education both with content and with required knowledge and skills attributes that are central to our mission.

Curriculum Requirements for a BA in Physics An Ignatian Foundation
All undergraduate students must complete either the Canisius Core Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/core-curriculum) or the All-College Honors Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/all-college-honors-program). Many schools refer to their college-wide undergraduate requirements as "general education" requirements. We believe that the core curriculum and the honors curriculum are more than a series of required classes; they provide the basis for a Jesuit education both with content and with required knowledge and skills attributes that are central to our mission.

Free Electives
Students may graduate with more but not less than 120 credit hours. Free electives are courses in addition to the Canisius Core Curriculum or All-College Honors Curriculum and major requirements sufficient to reach the minimum of 120 credit hours required for graduation.

Major Requirements

<table>
<thead>
<tr>
<th>Code</th>
<th>Title and Introduction to Programming Laboratory</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 111 &amp; 111L</td>
<td>Introduction to Programming and Introduction to Programming Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>PHY 223 &amp; 223L</td>
<td>General Physics for Physical Science Majors I and General Physics for Physical Science Majors I Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>PHY 224 &amp; 224L</td>
<td>General Physics for Physical Science Majors II and General Physics for Physical Science Majors I Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>PHY 225 &amp; 225L</td>
<td>General Physics for Physical Science Majors III and General Physics for Physical Science Majors III Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>PHY 226 &amp; 226L</td>
<td>Basic Electronics and Basic Electronics Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>PHY 350 or PHY 351</td>
<td>Modern Physics Laboratory or Advanced Laboratory</td>
<td>1</td>
</tr>
</tbody>
</table>

PHY 445 | Special Topics in Physics                                                                                      | 1       |
PHY 498 | Senior Project                                                                                                 | 1:3     |

Choose 4 of the following upper division courses: 12-14

- PHY 330 | Electrodynamics I                                                                                            |         |
- PHY 331 | Electrodynamics II                                                                                            |         |
- PHY 332 | Statistical and Thermal Physics                                                                                |         |
- PHY 335 | Mathematical Analysis for Physicists                                                                          |         |
- PHY 443 | Classical Mechanics                                                                                           |         |
- PHY 445 | Quantum Mechanics I                                                                                           |         |
- PHY 446 | Quantum Mechanics II                                                                                           |         |
- PHY 447 | Quantum Mechanics II                                                                                           |         |

CHM 111 | General Chemistry I                                                                                            | 4       |
CHM 112 | & 111L                                                                                                         |         |
MAT 111 | Calculus I                                                                                                     | 4       |
MAT 112 | Calculus II                                                                                                    | 4       |
MAT 211 | Calculus III                                                                                                   | 4       |
MAT 222 | Differential Equations                                                                                        | 3       |

Science Elective (choose one of the following): 4

- BIO 111 | Introductory Biology I and Introductory Biology Laboratory                                                   |         |
- CHM 112 | General Chemistry II and General Chemistry II Laboratory                                                      |         |
- CSC 112 | Data Structures and Data Structures Laboratory                                                                |         |
- MAT 219 | Linear Algebra                                                                                                |         |
- MAT 351 | Probability & Statistics I                                                                                    |         |

Total Credits | 58-62

Major Electives
Computer Science (http://catalog.canisius.edu/undergraduate/college-arts-sciences/computer-science) and Mathematics (http://catalog.canisius.edu/undergraduate/college-arts-sciences/mathematics-statistics) courses are highly recommended, particularly linear algebra.

Difference with the Physics BS Degree
The Physics BA degree program is designed to provide the basic topics in the field of physics and the tools to apply mathematical and scientific skills to different disciplines. This program is not a preparation for graduate school in physics or engineering. The program provides the students with the freedom to explore other programs like education, journalism, pre-law, pre-medicine, and finance, to name a few. The Physics BA is easier to double major than the Physics BS. Therefore, it has fewer major course requirements than the Physics BS degree. The first 2 years of both programs are identical. The Physics BA degree requires fewer major courses in the third and fourth years to allow the students to take a variety of electives and try different fields. The student is advised to consult the BS and BA Roadmaps for the specific differences.

Additional Course Considerations
Courses in the Junior and Senior years rotate on a two year basis. Please consult your advisor about which set of courses is available in any given year.

Note: Course availability may be a factor in determining time to degree completion for transfer students. Discussion with department faculty is highly recommended for transfer students.
**Roadmap**

**Recommended Semester Schedule for Major Course Requirements for a BA in Physics**

**Freshman**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT 111</td>
<td>MAT 112</td>
</tr>
<tr>
<td>CHM 111 &amp; 111L</td>
<td>Science elective¹</td>
</tr>
<tr>
<td>CSC 111 &amp; 111L</td>
<td>PHY 223 &amp; 223L</td>
</tr>
</tbody>
</table>

**Sophomore**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT 211</td>
<td>MAT 222</td>
</tr>
<tr>
<td>PHY 224 &amp; 224L</td>
<td>PHY 225 &amp; 225L</td>
</tr>
</tbody>
</table>

|               | PHY 226 & 226L         |

**Junior**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 350</td>
<td>PHY 351 (if did not take PHY 350)</td>
</tr>
<tr>
<td>PHY elective</td>
<td>PHY elective</td>
</tr>
</tbody>
</table>

**Senior**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY elective</td>
<td>PHY elective</td>
</tr>
</tbody>
</table>

|               | PHY 445                 |
|               | PHY 498                 |

¹ Science Elective to be chosen from BIO 111, CHM 112, CSC 112, MAT 219 or MAT 351. The science elective may be taken in a subsequent semester if it requires a prerequisite. In this case, take a course in the Core Curriculum in the spring semester of the freshman year.

**Student Learning Goals & Objectives**

**Student Learning Goal 1**

Physics majors will know how to learn physics.

Students will:

- **Objective A**: Critically assess written expositions of physics, contrasting those ideas which are fundamental from those which are consequential;
- **Objective B**: Identify the circumstances under which a principle applies.

**Student Learning Goal 2**

Physics majors are critical thinkers that can produce analytical solutions to physical problems.

Students will:

- **Objective A**: Identify a problem and generate equivalent statements of a problem;
- **Objective B**: Delineate the principles of physics and analytical techniques used to obtain a solution to a problem;
- **Objective C**: Apply the principles and techniques of physics to obtain a solution to a problem;
- **Objective D**: Demonstrate the correctness of a solution by showing that it yields expected results in limiting and other special cases.

**Student Learning Goal 3**

Physics majors possess the technical skills needed to function effectively in a physics laboratory.

Students will:

- **Objective A**: Collect a broad range of data with an ability to adapt to new experimental methods, apparatus and tools;
- **Objective B**: Apply fundamental statistical methods to analyze data;
- **Objective C**: Display data with clarity;
- **Objective D**: Draw sound conclusions from the results of data analysis.

**Student Learning Goal 4**

Physics majors communicate ideas in physics with precision and clarity.

Students will:

- **Objective A**: Produce precise and clear expository written material about physics;
- **Objective B**: Produce well-organized and clear oral presentations of physics material.

**Minor**

The physics minor requires seven courses, which are to be distributed as follows.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four Required Courses:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHY 223 &amp; 223L</td>
<td>General Physics for Physical Science Majors I and General Physics for Physical Science Majors I Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>PHY 224 &amp; 224L</td>
<td>General Physics for Physical Science Majors II and General Physics for Physical Science Majors I Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>PHY 225 &amp; 225L</td>
<td>General Physics for Physical Science Majors III and General Physics for Physical Science Majors I Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>MAT 211</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>Select three courses from the following two groups. At least one of these three must be selected from Group I:</td>
<td>8-12</td>
<td></td>
</tr>
</tbody>
</table>

**Group I:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 330</td>
<td>Electrodynamics¹³</td>
<td></td>
</tr>
<tr>
<td>PHY 331</td>
<td>Electrodynamics I²</td>
<td></td>
</tr>
<tr>
<td>PHY 332</td>
<td>Statistical and Thermal Physics⁵</td>
<td></td>
</tr>
<tr>
<td>PHY 443</td>
<td>Classical Mechanics</td>
<td></td>
</tr>
<tr>
<td>PHY 446</td>
<td>Quantum Mechanics I²</td>
<td></td>
</tr>
</tbody>
</table>

**Group II:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 226</td>
<td>Basic Electronics</td>
<td></td>
</tr>
<tr>
<td>MAT 222</td>
<td>Differential Equations</td>
<td></td>
</tr>
<tr>
<td>PHY 335</td>
<td>Mathematical Analysis for Physicists</td>
<td></td>
</tr>
<tr>
<td>PHY 447</td>
<td>Quantum Mechanics II</td>
<td></td>
</tr>
<tr>
<td>CHM 301 &amp; 301L</td>
<td>Fundamental Physical Chemistry and Fundamental Physical Chemistry Laboratory</td>
<td></td>
</tr>
</tbody>
</table>

**Total Credits**: 24-28

¹ PHY 331 requires PHY 330 as a prerequisite.
² PHY 446 is required for PHY 447.
³ PHY 335 is highly recommended as a co-requisite for PHY 330.
Courses

PHY 129 Introduction to Astronomy 3 Credits
Understanding modern astronomy by using ideas from basic physics. Mathematics minimized. Naming and viewing stars and constellations is included.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: fall.

PHY 130 Introductory Geology 3 Credits
For science and non-science majors alike, this course covers the fundamental concepts of physical geology, including the rock cycle; erosion; tectonic processes including earthquakes and volcanism; the importance of water from oceans to rivers to glaciers; and society's dependence on energy and mineral resources from the Earth. Our planet is an interacting system of matter and energy, giving us mountains, lowlands, oceans, rivers, earthquakes, volcanoes, and the resources we need for human prosperity.
Offered: every fall.

PHY 131 Earthquakes: Seismology and Society 3 Credits
The science behind earthquakes: causes, locations, frequency and measurement; affects on geography, human structures and society.
Fulfills College Core: Field 6 (Natural Sciences), Global Awareness
Offered: fall.

PHY 132 Dinosaurs 3 Credits
An introduction to dinosaurs and their world through an examination of their anatomy, evolution, phylogeny, behavior, metabolism and the cause of their extinction. Exploration of geological concepts such as uniformitarianism, stratigraphy, sedimentation, fossilization and taphonomy will help to explain how this knowledge was extracted from the rocks.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: spring.

PHY 201 College Physics I 3 Credits
College Physics for biological-science students. Mechanics of rigid bodies, mechanics of fluids, thermal energy and thermodynamics.
Prerequisite: MAT 110 or MAT 111. Corequisite: PHY 201L.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: every fall.

PHY 201L College Physics I Laboratory 1 Credit
Laboratory for College Physics I for biological-science students.
Prerequisite: MAT 110 or MAT 111. Corequisite: PHY 201.
Offered: every fall.

PHY 202 College Physics II 3 Credits
College Physics for biological-science students. Electricity and magnetism, geometrical and physical optics.
Prerequisite: minimum grade of C- in PHY 201 and 201L. Corequisite: PHY 202L.
Offered: spring.

PHY 202L College Physics II Laboratory 1 Credit
Laboratory for College Physics II for biological-science students.
Prerequisite: min grade of C- in PHY 201 and 201L Corequisite: PHY 202.
Offered: spring.

PHY 203 College Physics III 3 Credits
Prerequisite: PHY 202L. Corequisite: PHY 203L.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: every fall.

PHY 204L College Physics III Laboratory 1 Credit
Laboratory for calculus-based general physics I.
Prerequisite: PHY 203L.
Offered: every fall.

PHY 205 College Physics IV 3 Credits
Calculus-based general physics. Electricity and magnetism, geometrical and physical optics.
Prerequisite: minimum grade of C- in PHY 204 and 204L. Corequisite: PHY 205L.
Offered: every spring.

PHY 206L College Physics IV Laboratory 1 Credit
Laboratory for calculus-based general physics II.
Prerequisite: PHY 205L.
Offered: every spring.

PHY 211 College Physics V 3 Credits
Prerequisite: PHY 201 & minimum grade of C- in PHY 211. Corequisite: PHY 211L.
Offered: spring.

PHY 212L College Physics V Laboratory 1 Credit
Laboratory for calculus-based general physics III.
Prerequisite: PHY 211.
Offered: every fall.

PHY 213 College Physics VI 3 Credits
Prerequisite: PHY 212L. Corequisite: PHY 213L.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: every spring.

PHY 214L College Physics VI Laboratory 1 Credit
Laboratory for calculus-based general physics IV.
Prerequisite: PHY 213L.
Offered: every spring.

PHY 215 College Physics VII 3 Credits
Calculus-based general physics. Electricity and magnetism, geometrical and physical optics.
Prerequisite: minimum grade of C- in PHY 214 and 214L. Corequisite: PHY 215L.
Offered: spring.

PHY 216L College Physics VII Laboratory 1 Credit
Laboratory for calculus-based general physics V.
Prerequisite: PHY 215L.
Offered: every spring.

PHY 217 College Physics VIII 3 Credits
Prerequisite: PHY 216L. Corequisite: PHY 217L.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: spring.

PHY 218L College Physics VIII Laboratory 1 Credit
Laboratory for calculus-based general physics VI.
Prerequisite: PHY 217L.
Offered: spring.

PHY 219 College Physics IX 3 Credits
Calculus-based general physics. Electricity and magnetism, geometrical and physical optics.
Prerequisite: minimum grade of C- in PHY 218 and 218L. Corequisite: PHY 219L.
Offered: spring.

PHY 219L College Physics IX Laboratory 1 Credit
Laboratory for calculus-based general physics VII.
Prerequisite: PHY 219L.
Offered: spring.

PHY 220 College Physics X 3 Credits
Prerequisite: PHY 219 & minimum grade of C- in PHY 220. Corequisite: PHY 220L.
Offered: spring.

PHY 220L College Physics X Laboratory 1 Credit
Laboratory for calculus-based general physics VIII.
Prerequisite: PHY 220L.
Offered: every fall.

PHY 221 College Physics XI 3 Credits
Prerequisite: PHY 220 & minimum grade of C- in PHY 221. Corequisite: PHY 221L.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: every spring.

PHY 221L College Physics XI Laboratory 1 Credit
Laboratory for calculus-based general physics IX.
Prerequisite: PHY 221L.
Offered: every spring.

PHY 222 College Physics XII 3 Credits
Prerequisite: PHY 221 & minimum grade of C- in PHY 222. Corequisite: PHY 222L.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: spring.

PHY 222L College Physics XII Laboratory 1 Credit
Laboratory for calculus-based general physics X.
Prerequisite: PHY 222L.
Offered: every spring.

PHY 223 General Physics for Physical Science Majors I 3 Credits
Prerequisite: PHY 222L. Corequisite: PHY 223L.
Fulfills College Core: Field 6 (Natural Sciences)
Offered: spring.

PHY 223L General Physics for Physical Science Majors I Laboratory 1 Credit
Laboratory for calculus-based general physics I.
Prerequisite: PHY 223L.
Offered: spring.

PHY 224 General Physics for Physical Science Majors II 3 Credits
Calculus-based general physics. Electricity and magnetism, geometrical and physical optics.
Prerequisite: minimum grade of C- in PHY 223 and PHY 223L. Corequisite: PHY 224L.
Offered: fall.

PHY 224L General Physics for Physical Science Majors II Laboratory 1 Credit
Laboratory for calculus-based general physics II.
Prerequisite: PHY 224L.
Offered: fall.

PHY 225 General Physics for Physical Science Majors III 3 Credits
Prerequisite: PHY 224 & minimum grade of C- in PHY 225. Corequisite: PHY 225L.
Offered: spring.

PHY 225L General Physics for Physical Science Majors III Laboratory 1 Credit
Laboratory for calculus-based general physics III.
Corequisite: PHY 225.
Offered: spring.

PHY 226 Basic Electronics 3 Credits
Circuit analysis, power supplies, semiconductor physics, operational amplifiers, digital electronics. Integrated circuit techniques. Includes laboratory work each week.
Prerequisite: minimum grade of C- in PHY 224. Corequisite: PHY 226L.
Offered: spring.

PHY 226L Basic Electronics Laboratory 1 Credit
Laboratory for basic electronics course.
Corequisite: PHY 226.
Offered: every spring.

PHY 330 Electrodynamics I 3 Credits
Static and time-varying classical electric and magnetic fields in free-space and matter. Prior completion of or concurrent registration for PHY 335 is strongly encouraged.
Prerequisite: PHY 224.
Offered: fall of odd-numbered years.

PHY 331 Electrodynamics II 3 Credits
Primary topic: electromagnetic waves in free-space and matter, beginning with the Maxwell equations. Additional topics: radiation and special relativity.
Prerequisite: PHY 330.
Offered: spring of even-numbered years.

PHY 332 Statistical and Thermal Physics 3 Credits
Develops statistical concepts and methods used to relate macroscopic to microscopic descriptions of many particle systems.
Prerequisite: PHY 225.
Offered: spring of odd-numbered years.
PHY 335 Mathematical Analysis for Physicists 4 Credits
Theory and applications of infinite series, Fourier series, Green's functions, Fourier integrals, vector calculus, linear algebra, partial differential equations, and complex variable.
Prerequisite: MAT 222 or permission of instructor.
Offered: fall of odd-numbered years.

PHY 350 Modern Physics Laboratory 1 Credit
This course covers the basic principles of 20th century modern physics. The topics include blackbody radiation, particle/wave duality, x-ray diffraction, Bohr’s model of the atom, quantum tunneling, and the Schrodinger equation.
Prerequisite: PHY 225.
Fulfills College Core: Advanced Writing-Intensive
Offered: every fall.

PHY 351 Advanced Laboratory 1 Credit
This course emphasizes advanced experiments and experimental technique. Topics include, but are not restricted to, dosimetry, radiation detection, gamma-ray spectroscopy, Rutherford scattering, atomic spectroscopy, thin-film deposition, and magnetic resonance.
Prerequisite: PHY 225.
Fulfills College Core: Oral Communication
Offered: every spring.

PHY 443 Classical Mechanics 3 Credits
One, two, and three dimensional motion of a particle, non-inertial systems, classical scattering, rigid-body motion. Lagrange and Hamilton equations, calculus of variations, oscillations.
Prerequisite: PHY 224 & MAT 222.
Offered: fall of even-numbered years.

PHY 445 Special Topics in Physics 1 Credit
This course will cover model formation and development using archival journal articles in physics. The subject material will rotate by semester among topics such as astrophysics, quantum theory, and thermodynamics. Students will be expected to read and critique journal articles, lead discussions on journal articles, and trace the development of an area of physics through assigned readings.
Prerequisite: permission of instructor. Restriction: must be physics major or minor with senior standing.
Offered: spring of odd-numbered years.

PHY 446 Quantum Mechanics I 4 Credits
Corequisite: PHY 225 & MAT 222.
Offered: fall of even-numbered years.

PHY 447 Quantum Mechanics II 3 Credits
Application of Schrodinger's equation, Hamiltonian mechanics, angular momentum, intrinsic spin, parity, and time-dependent quantum mechanics. PHY 446 is highly recommended.
Offered: spring of odd-numbered years.

PHY 449 Nuclear Physics Lab 1 Credit
Introduction to experimental nuclear physics. Experiments study nuclear instrumentation, characteristics of radiation and nuclear spectra.
Prerequisite: PHY 446.
Fulfills College Core: Advanced Writing-Intensive
Offered: occasionally.

PHY 498 Senior Project 1-3 Credits
A one-semester research project done under the supervision of a faculty member.
Prerequisite: permission of department chair. Restriction: senior standing in physics.
Offered: spring.

PHY 499 Independent Study 1-3 Credits
An independent study with a faculty member of the Physics Department. Independent studies require an application and approval by the associate dean.
Prerequisite: permission of the instructor, department chair, & associate dean. Restriction: permission of the chair.
Offered: fall & spring.