PHYSICS

• Bachelor of Science, Physical Science (p. 1)
• Bachelor of Science, Physics (p. 2)
• Bachelor of Science, Physics-Computer Science (p. 3)

Minor

• Physics (p. 4)

The program leading to the Bachelor of Science with a major in physics is designed to provide a strong yet versatile basis for a subsequent scientific career or advanced study. Minimum requirements for all majors are listed below, but students planning for graduate work in physics or an allied area are advised to select additional mathematics and physics courses. A physics major must complete all 300-400-level courses with a 2.0 minimum grade-point average.

Students have the option of adding a multidisciplinary concentration in electro-optics to their physics degree. The concentration is appropriate for physics majors who wish to pursue possible careers in photonics or graduate degrees in the area of optics.

PHY, PSC, and PCS majors are required to attain a grade of C- or better in all physics and math courses that are prerequisite courses for physics courses required of majors.

A minor in physics consists of twelve semester hours.

Faculty
Todd Smith, Interim Chairperson
Distinguished Service Professor: O’Hare
Professors Emeriti: Berney, Craver, Erdei, Graham, Miner, O’Hare, Yaney
Professors: Brecha, Elhamri, Ewvaraye, Pedrotti
Associate Professors: Agha, Ahoujja, Chong, Mathews, T. Smith, Zhao
Assistant Professors: Plick, Sudakov
Visiting Assistant Professor: Ojha
Lecturers: Kariyawasam, Merithew
Lab Instructors: Hirst, Powers, Schauer, E. Smith

Bachelor of Science, Physical Science (PSC) minimum 120 hours

The Physical Science Program is administered by the Department of Physics. It provides a broad training in the physical sciences that is desirable for one who plans to pursue a goal built on a composite science background. The physical science major combines adequate physics, chemistry, geology, and mathematics to provide a sound working knowledge of physical science. Since the program is less specialized than one in a single science, it has provision for adequate course selections and sufficient electives to provide the opportunity for concentrated study in a discipline chosen to meet the career objectives of the individual student.

Common Academic Program (CAP) 1

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>HST 103</td>
<td>The West &amp; the World</td>
<td>3</td>
</tr>
<tr>
<td>REL 103</td>
<td>Introduction to Religious and Theological Studies</td>
<td>3</td>
</tr>
<tr>
<td>PHL 103</td>
<td>Introduction to Philosophy</td>
<td>3</td>
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</table>

First-Year Humanities Commons 2

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG 100</td>
<td>Writing Seminar I</td>
<td>0-3</td>
</tr>
<tr>
<td>ENG 200</td>
<td>Second-Year Writing Seminar</td>
<td>0-3</td>
</tr>
<tr>
<td>CMM 100</td>
<td>Principles of Oral Communication</td>
<td>3</td>
</tr>
<tr>
<td>Social Science</td>
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</tr>
<tr>
<td>SSC 200</td>
<td>Social Science Integrated</td>
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Crossing Boundaries

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<th>Course Title</th>
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<tr>
<td>Faith Traditions</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Practical Ethical Action</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Inquiry 6</td>
<td></td>
<td>3</td>
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<tr>
<td>Integrative</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Advanced Study</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Philosophy and/or Religious Studies (6 cr. hrs.)</td>
<td>6</td>
<td></td>
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<tr>
<td>Historical Studies (3 cr. hrs.) 7</td>
<td>3</td>
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<td>Diversity and Social Justice 8</td>
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<tr>
<td>Major Capstone 9</td>
<td>0-6</td>
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</table>

1 The credit hours listed reflect what is needed to complete each CAP component. However, they should not be viewed as a cumulative addition to a student’s degree requirements because many CAP courses are designed to satisfy more than one CAP component (e.g., Crossing Boundaries and Advanced Studies) and may also satisfy requirements in the student’s major.

2 May be completed with ASI 110 and ASI 120 through the Core Program.

3 May be completed with ENG 100A and ENG 100B by placement.

4 May be completed with ENG 114 or ENG 198 or ASI 120.

5 Must include two different disciplines and at least one accompanying lab.

6 U.S. History AP and CLEP credit will not satisfy this requirement.

7 May be completed with ASI 110 and ASI 120 through the Core Program. U.S. History AP and CLEP credit will not satisfy this requirement.
May not double count with First-Year Humanities Commons, Second-Year Writing, Oral Communication, Social Science, Arts, or Natural Sciences CAP components, but may double count with courses taken to satisfy other CAP components and/or courses taken in the student’s major.

The course or experience is designed by faculty in each major; it may, or may not, be assigned credit hours.

Science Breadth Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>CPS 132</td>
<td>Computer Programming for Engineering &amp; Science</td>
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<tr>
<td>or CPS 150</td>
<td>Algorithms &amp; Programming I</td>
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<tr>
<td>MTH 168</td>
<td>Analytic Geometry &amp; Calculus I (Satisfies CAP Mathematics)</td>
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<tr>
<td>MTH 169</td>
<td>Analytic Geometry &amp; Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>MTH 218</td>
<td>Analytic Geometry &amp; Calculus III</td>
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<tr>
<td>MTH 219</td>
<td>Applied Differential Equations</td>
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</table>

Major Requirements 54

(Satisfies CAP Natural Science)

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<thead>
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<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tr>
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<td>&amp; 123L</td>
<td>and General Chemistry Laboratory</td>
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<tr>
<td>CHM 124</td>
<td>General Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 124L</td>
<td>and General Chemistry Laboratory</td>
<td></td>
</tr>
<tr>
<td>GEO 115</td>
<td>Physical Geology</td>
<td>4</td>
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<tr>
<td>&amp; 115L</td>
<td>and Physical Geology Laboratory</td>
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<tr>
<td>GEO 116</td>
<td>Geological History of the Earth</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 116L</td>
<td>and Geological History of the Earth Laboratory</td>
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<tr>
<td>PHY 206</td>
<td>General Physics I - Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHY 207</td>
<td>General Physics II - Electricity &amp; Magnetism</td>
<td>3</td>
</tr>
<tr>
<td>PHY 208</td>
<td>General Physics III - Thermodynamics, Waves, and Fluids</td>
<td>3</td>
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<tr>
<td>PHY 210L</td>
<td>General Physics Laboratory I</td>
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<td>PHY 211L</td>
<td>General Physics Laboratory II</td>
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<tr>
<td>PHY 321</td>
<td>General Physics IV - Modern Physics</td>
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<tr>
<td>PHY 480</td>
<td>Physics Capstone (Satisfies CAP Major Capstone)</td>
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<td>Physical science courses (300/400 level)</td>
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Total Hours 108

Breadth

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<tr>
<th>Course</th>
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<th>Credits</th>
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<tr>
<td>ASI 150</td>
<td>Introduction to the University Experience</td>
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</tr>
<tr>
<td>Social and Behavioral Sciences (includes CAP Social Science)</td>
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<td>6</td>
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</table>

Total Hours to total at least 120

Bachelor of Science, Physics (PHY) minimum 120 hours

Common Academic Program (CAP) 1

First-Year Humanities Commons 2

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>HST 103</td>
<td>The West &amp; the World</td>
<td>12 cr.</td>
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<tr>
<td>REL 103</td>
<td>Introduction to Religious and Theological Studies</td>
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</tr>
<tr>
<td>PHL 103</td>
<td>Introduction to Philosophy</td>
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<tr>
<td>ENG 100</td>
<td>Writing Seminar I</td>
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Second-Year Writing Seminar 4

<table>
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<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>ENG 200</td>
<td>Writing Seminar II</td>
<td></td>
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<tr>
<td>Oral Communication</td>
<td></td>
<td>3 cr.</td>
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</tbody>
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CMM 100 | Principles of Oral Communication | 3 cr. |

Social Science | 3 cr. |

SSC 200 | Social Science Integrated | 3 cr. |

Arts | 3 cr. |

Natural Sciences 5

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faith Traditions</td>
<td></td>
<td></td>
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<tr>
<td>Practical Ethical Action</td>
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<tr>
<td>Inquiry 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced Study</td>
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<td>Diversity and Social Justice 8</td>
<td></td>
<td>3 cr.</td>
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<td>Major Capstone 9</td>
<td></td>
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Physics 3

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<td>Applied Differential Equations</td>
<td>3</td>
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<tr>
<td>MTH 301</td>
<td>Matrix Theory and Applications</td>
<td>3</td>
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<tr>
<td>or MTH 310</td>
<td>Linear Algebra &amp; Matrices</td>
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### Major Requirements

Select one concentration from:

#### General Physics Concentration 40 credits

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>PHY 206</td>
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<td>PHY 207</td>
<td>General Physics II - Electricity &amp; Magnetism</td>
<td>3</td>
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<td>PHY 208</td>
<td>General Physics III- Thermodynamics, Waves, and Fluids</td>
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</tr>
<tr>
<td>PHY 210L</td>
<td>General Physics Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>PHY 211L</td>
<td>General Physics Laboratory II</td>
<td>1</td>
</tr>
<tr>
<td>PHY 301</td>
<td>Thermal Physics</td>
<td>3</td>
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<tr>
<td>PHY 303</td>
<td>Intermediate Mechanics I</td>
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<tr>
<td>PHY 321</td>
<td>General Physics IV - Modern Physics</td>
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<tr>
<td>PHY 333</td>
<td>Digital &amp; Analog Electronics for Scientists</td>
<td>3</td>
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<tr>
<td>PHY 390</td>
<td>Introduction to Quantum Mechanics</td>
<td>3</td>
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<td>PHY 408</td>
<td>Intermediate Electricity &amp; Magnetism I</td>
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<tr>
<td>PHY 430</td>
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<td>PHY 431</td>
<td>Advanced Lab II</td>
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<td>PHY 480</td>
<td>Physics Capstone (Satisfies CAP Major Capstone)</td>
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<td>PHY electives (300/400 level)</td>
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#### Physics and Electro-Optics Concentration 43 credits

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<tbody>
<tr>
<td>ECE 443</td>
<td>Introduction to Electro-Optics</td>
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<td>PHY 206</td>
<td>General Physics I - Mechanics (Applies to Cap Natural Science)</td>
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<td>PHY 207</td>
<td>General Physics II - Electricity &amp; Magnetism</td>
<td>3</td>
</tr>
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<td>PHY 208</td>
<td>General Physics III- Thermodynamics, Waves, and Fluids</td>
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<tr>
<td>PHY 210L</td>
<td>General Physics Laboratory I</td>
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<tr>
<td>PHY 211L</td>
<td>General Physics Laboratory II</td>
<td>1</td>
</tr>
<tr>
<td>PHY 301</td>
<td>Thermal Physics</td>
<td>3</td>
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<tr>
<td>PHY 303</td>
<td>Intermediate Mechanics I</td>
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<tr>
<td>PHY 333</td>
<td>Digital &amp; Analog Electronics for Scientists</td>
<td>3</td>
</tr>
<tr>
<td>PHY 390</td>
<td>Introduction to Quantum Mechanics</td>
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<td>PHY 404</td>
<td>Physical Optics</td>
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<tr>
<td>PHY 408</td>
<td>Intermediate Electricity &amp; Magnetism I</td>
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<td>PHY 430</td>
<td>Advanced Lab I</td>
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<td>PHY 431</td>
<td>Advanced Lab II</td>
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<td>PHY 480</td>
<td>Physics Capstone (Satisfies CAP Major Capstone)</td>
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Select two courses from:

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<tbody>
<tr>
<td>EOP 501</td>
<td>Fundamentals of Optical Design</td>
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<tr>
<td>EOP 502</td>
<td>Light and Matter Interaction</td>
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<tr>
<td>EOP 505</td>
<td>Introduction to Lasers</td>
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<tr>
<td>EOP 506</td>
<td>Photonic Devices &amp; Systems</td>
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<tr>
<td>or ECE 573</td>
<td>Photonic Devices &amp; Systems</td>
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<td>EOP 514</td>
<td>Guided-Wave Optics</td>
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<tr>
<td>or ECE 574</td>
<td>Guided-Wave Optics</td>
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</table>

### Breadth

ASI 150 | Introduction to the University Experience | 1 |
Social Science and Behavioral Science (Includes CAP Social Science) | 6 |

Total Hours to total at least 120

### Bachelor of Science, Physics-Computer Science (PCS) minimum 120 hours

This combined program in physics and computer science leading to the Bachelor of Science with a major in Physics-Computer Science emphasizes the use of computer software in scientific applications and at the same time gives a foundation in the scientific disciplines of physics and computer science. Minimum requirements for the degree are listed below. Students are advised to select additional computer science, mathematics, and physics courses as electives. For further information contact the Physics Department.

#### Common Academic Program (CAP) 1

First-Year Humanities Commons | 12 cr. hrs.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
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<td>PHL 103</td>
<td>Introduction to Philosophy</td>
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<tr>
<td>ENG 100</td>
<td>Writing Seminar I</td>
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Second-Year Writing Seminar | 0-3 cr. hrs.

<table>
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<tbody>
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<td>Writing Seminar II</td>
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<td>CMM 100</td>
<td>Principles of Oral Communication</td>
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<td>SSC 200</td>
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Oral Communication | 3 cr. hrs.

<table>
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<tbody>
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### Bachelor of Science, Physical Science

#### First Year

**Fall**

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<tr>
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<tr>
<td>PHY 206</td>
<td>General Physics I - Mechanics</td>
</tr>
<tr>
<td>&amp; PHY 210L</td>
<td>General Physics Laboratory I</td>
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<tr>
<td>CHM 123</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>MTH 168</td>
<td>Analytic Geometry &amp; Calculus I</td>
</tr>
<tr>
<td>&amp; MTH 169</td>
<td>Analytic Geometry &amp; Calculus II</td>
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<tr>
<td>&amp; MTH 170</td>
<td>Analytic Geometry &amp; Calculus III</td>
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**Spring**

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<td>PHY 206</td>
<td>General Physics I - Mechanics</td>
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<tr>
<td>&amp; PHY 210L</td>
<td>General Physics Laboratory I</td>
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<tr>
<td>CHM 123</td>
<td>General Chemistry I</td>
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<td>MTH 168</td>
<td>Analytic Geometry &amp; Calculus I</td>
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<td>&amp; MTH 169</td>
<td>Analytic Geometry &amp; Calculus II</td>
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<tr>
<td>&amp; MTH 170</td>
<td>Analytic Geometry &amp; Calculus III</td>
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</table>

**Total Hours: 12**

- Bachelor of Science, Physical Science (p. 4)
- Bachelor of Science, Physics (p. 5)
- Bachelor of Science, Physics - Computer Science (p. 5)

#### Minor in Physics (PHY)

Select four PHY courses (300/400 level)

**Total Hours: 12**

- Bachelor of Science, Physical Science (p. 4)
- Bachelor of Science, Physics (p. 5)
- Bachelor of Science, Physics - Computer Science (p. 5)

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1. The credit hours listed reflect what is needed to complete each CAP component. However, they should not be viewed as a cumulative addition to a student’s degree requirements because many CAP courses are designed to satisfy more than one CAP component (e.g., Crossing Boundaries and Advanced Studies) and may also satisfy requirements in the student’s major.

2. May be completed with ASI 110 and ASI 120 through the Core Program.

3. May be completed with ENG 100A and ENG 100B, by placement.

4. May be completed with ENG 114 or ENG 198 or ASI 120.

5. Must include two different disciplines and at least one accompanying lab.

6. U.S. History AP and CLEP credit will not satisfy this requirement.

7. May be completed with ASI 110 and ASI 120 through the Core Program. U.S. History AP and CLEP credit will not satisfy this requirement.

8. May not double count with First-Year Humanities Commons, Second-Year Writing, Oral Communication, Social Science, Arts, or Natural Sciences CAP components, but may double count with courses taken to satisfy other CAP components and/or courses taken in the student’s major.

9. The course or experience is designed by faculty in each major; it may, or may not, be assigned credit hours.

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### Major Requirements

(Satisfies CAP Mathematics and CAP Natural Science)

**Computer Science**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
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</thead>
<tbody>
<tr>
<td>CPS 150</td>
<td>Algorithms &amp; Programming I</td>
</tr>
<tr>
<td>CPS 151</td>
<td>Algorithms &amp; Programming II</td>
</tr>
<tr>
<td>CPS 250</td>
<td>Computer Organization and Architecture</td>
</tr>
<tr>
<td>CPS 350</td>
<td>Data Structures &amp; Algorithms</td>
</tr>
</tbody>
</table>

**Total Hours: 26**

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### Breadth Requirements

- ASI 150 Introduction to the University Experience (1 credit hour)
- Social and Behavioral Sciences (includes CAP Social Science) (6 credit hours)

**Total Hours to total at least: 120**

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1. Additional numerical analysis courses are recommended.
### Bachelor of Science, Physics

<table>
<thead>
<tr>
<th>First Year</th>
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<tbody>
<tr>
<td><strong>Fall</strong></td>
</tr>
<tr>
<td>ASI 150</td>
</tr>
<tr>
<td>PHY 206</td>
</tr>
<tr>
<td>&amp; PHY 211L (CAP Natural Science w/lab)</td>
</tr>
<tr>
<td>CHM 123</td>
</tr>
<tr>
<td>MTH 168 (Satisfies CAP Mathematics)</td>
</tr>
<tr>
<td><strong>Spring</strong></td>
</tr>
<tr>
<td>PHY 207</td>
</tr>
<tr>
<td>&amp; PHY 211L</td>
</tr>
<tr>
<td>CHM 124L</td>
</tr>
<tr>
<td>MTH 116</td>
</tr>
<tr>
<td>HST 103, PHL 103, or REL 103 (CAP Humanities Commons)</td>
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<table>
<thead>
<tr>
<th>Second Year</th>
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<tbody>
<tr>
<td><strong>Fall</strong></td>
</tr>
<tr>
<td>PHY 208</td>
</tr>
<tr>
<td>GEO 115</td>
</tr>
<tr>
<td>&amp; 115L (CAP Natural Science w/lab)</td>
</tr>
<tr>
<td>MTH 218</td>
</tr>
<tr>
<td>CM 123L</td>
</tr>
<tr>
<td>ENG 200 (CAP Writing Seminar)</td>
</tr>
<tr>
<td><strong>Spring</strong></td>
</tr>
<tr>
<td>PHY elective</td>
</tr>
<tr>
<td>GEO 116</td>
</tr>
<tr>
<td>MTH 219</td>
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<tr>
<td>CM 124L</td>
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<td>CAP (Communication)</td>
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<td>ENG 200 (CAP Writing Seminar)</td>
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<table>
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<tr>
<th>Third Year</th>
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<tbody>
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<td><strong>Fall</strong></td>
</tr>
<tr>
<td>PHY elective</td>
</tr>
<tr>
<td>PHY elective</td>
</tr>
<tr>
<td>CPS 132 or 150</td>
</tr>
<tr>
<td><strong>Spring</strong></td>
</tr>
<tr>
<td>PHY elective</td>
</tr>
<tr>
<td>CPS 132 or 150</td>
</tr>
<tr>
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<td>ENG 200 (CAP Writing Seminar)</td>
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<table>
<thead>
<tr>
<th>Fourth Year</th>
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</thead>
<tbody>
<tr>
<td><strong>Fall</strong></td>
</tr>
<tr>
<td>PHY 480 (Satisfies CAP Major Capstone)</td>
</tr>
<tr>
<td>PHY elective</td>
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<tr>
<td>PHY elective</td>
</tr>
<tr>
<td>CAP (Integrative)</td>
</tr>
<tr>
<td><strong>Spring</strong></td>
</tr>
<tr>
<td>PHY 431</td>
</tr>
<tr>
<td>PHY elective</td>
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<tr>
<td>CAP (Integrative)</td>
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<tr>
<td><strong>Total credit hours: 128-129</strong></td>
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### Bachelor of Science, Physics-Computer Science

<table>
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<tr>
<th>First Year</th>
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<tbody>
<tr>
<td><strong>Fall</strong></td>
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<tr>
<td>ASI 150</td>
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<tr>
<td>PHY 206</td>
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<tr>
<td>&amp; 210L (CAP Natural Science w/lab)</td>
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<tr>
<td>CHM 123</td>
</tr>
<tr>
<td>MTH 168 (Satisfies CAP Mathematics)</td>
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<tr>
<td><strong>Spring</strong></td>
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<tr>
<td>PHY 207</td>
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<tr>
<td>CHM 124L</td>
</tr>
<tr>
<td>MTH 116</td>
</tr>
<tr>
<td>HST 103, PHL 103, or REL 103 (CAP Humanities Commons)</td>
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<td><strong>Fall</strong></td>
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<td>PHY 208</td>
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<tr>
<td><strong>Fall</strong></td>
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<tr>
<td>PHY 480 (Satisfies CAP Major Capstone)</td>
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<tr>
<td>PHY 430</td>
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<td>PHY elective</td>
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<td>CAP (Integrative)</td>
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<tr>
<td>CAP (Integrative)</td>
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<tr>
<td><strong>Total credit hours: 127-128</strong></td>
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</tbody>
</table>
Total credit hours: 123

<table>
<thead>
<tr>
<th>Courses</th>
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<tbody>
<tr>
<td><strong>PHY 100. Seminar. 0 Hours</strong></td>
</tr>
<tr>
<td>Opportunity to become acquainted with the broad spectrum of modern science through periodic meetings with the entire department. Invited speakers, films, student presentations, book reviews, and informal discussions. For all physics, physical science, and physics-computer science majors.</td>
</tr>
<tr>
<td><strong>PHY 105. Physical Science - Energy &amp; the Environment. 3 Hours</strong></td>
</tr>
<tr>
<td>General introduction to principles of physics including motion, energy, thermodynamics, electricity and magnetism, and nuclear physics. Applications of these principles to non-renewable and renewable energy systems and the climate. Intended for business students.</td>
</tr>
<tr>
<td><strong>PHY 108. Physical Science of Light &amp; Color. 3 Hours</strong></td>
</tr>
<tr>
<td>Conceptual study of physical science with emphasis on light, color, and the interaction of light with materials.</td>
</tr>
<tr>
<td><strong>PHY 201L. College Physics Laboratory I. 1 Hour</strong></td>
</tr>
<tr>
<td>Laboratory experiences to accompany PHY 101. Corequisite(s): PHY 201.</td>
</tr>
<tr>
<td><strong>PHY 202. College Physics II. 3 Hours</strong></td>
</tr>
<tr>
<td>Continuation of PHY 201 with a treatment of electricity and magnetism, wave motion and properties of light, atomic and nuclear physics. Second term, each year. Prerequisite(s): PHY 201.</td>
</tr>
<tr>
<td><strong>PHY 203. Modern Technical Physics. 3 Hours</strong></td>
</tr>
<tr>
<td>Introduction to selected topics in modern physics without the formalism of calculus. For engineering technology students. Prerequisite(s): College algebra, trigonometry, and introductory statics and dynamics.</td>
</tr>
<tr>
<td><strong>PHY 203L. Technical Physics Laboratory. 1 Hour</strong></td>
</tr>
<tr>
<td>Laboratory experiences to accompany PHY 203.</td>
</tr>
<tr>
<td><strong>PHY 206. General Physics I - Mechanics. 3 Hours</strong></td>
</tr>
<tr>
<td>Calculus-based introductory course in mechanics. Three lectures, one recitation each week. Corequisites: MTH 148 or MTH 168.</td>
</tr>
<tr>
<td><strong>PHY 207. General Physics II - Electricity &amp; Magnetism. 3 Hours</strong></td>
</tr>
<tr>
<td>The basic principles of electricity and magnetism. Three lectures, one recitation each week. Prerequisite(s): PHY 201 or PHY 206. Corequisite(s): MTH 149 or MTH 169.</td>
</tr>
<tr>
<td><strong>PHY 208. General Physics III- Thermodynamics, Waves, and Fluids. 3 Hours</strong></td>
</tr>
<tr>
<td>Introduction to wave phenomena (including mechanical waves, sound waves, physical optics and geometrical optics), thermal physics, and fluids. Prerequisite(s): (MTH 149; PHY 202) or (MTH 169; PHY 207).</td>
</tr>
<tr>
<td><strong>PHY 210L. General Physics Laboratory I. 1 Hour</strong></td>
</tr>
<tr>
<td>Introduction to laboratory methods, handling of data, and analysis of results. Experiments appropriate to the background of students with an interest in mathematics and physical sciences. Two hours laboratory, one hour recitation each week. Corequisites: PHY 206.</td>
</tr>
</tbody>
</table>
PHY 211L. General Physics Laboratory II. 1 Hour
Laboratory methods, data handling, and analysis of results. Experiments appropriate to the background of students with an interest in mathematical and physical sciences. Two hours laboratory, one hour recitation each week. Prerequisite(s): PHY 210L. Corequisite(s): PHY 207.

PHY 220. Energy & Environmental Physics. 3 Hours
Introduction to the physical basis of energy systems and the climate. Topics covered will include thermodynamics, planetary radiation balance, heat transfer, basic atmospheric and ocean physics, nuclear energy, renewable energy, modeling of carbon emissions from fossil fuels, simple climate models, monitoring climate change, and mitigation strategies. Prerequisite(s): PHY 206.

PHY 232. The Physics of Waves. 3 Hours
Examination of analytical approaches and conceptual frameworks of physics applied to wave phenomena in a variety of physical systems. Topics include oscillation in mechanical and electrical systems, mechanical and electromagnetic waves, and geometrical and physical optics. This course is designed for electrical and computer engineering students, but is open to all meeting the prerequisites. Prerequisite(s): PHY 206, MTH 169 (may be taken as co-requisite).

PHY 250. Descriptive Astronomy. 3-4 Hours
Descriptive survey for students who have had little or no previous exposure to astronomy; material from ancient times to present, including pulsars and quasi-stellar objects.

PHY 295. Research Participation I. 1 Hour
No description available.

PHY 301. Thermal Physics. 3 Hours
Thermodynamical descriptions of many particle systems obtained from microscopic statistical considerations; laws of thermodynamics, kinetic theory of dilute gases, and Fermi-Dirac and Bose-Einstein statistics. Prerequisite(s): PHY 208 or PHY 232. Corequisite(s): MTH 219.

PHY 303. Intermediate Mechanics I. 3 Hours
The fundamental concepts of mechanics: virtual work, kinematics, special theory of relativity, Lagrange's equation-and central forces, particle dynamics. Prerequisite(s): PHY 208 or PHY 232. Corequisite(s): MTH 219.

PHY 321. General Physics IV - Modern Physics. 3 Hours
Introduction to modern physics. Topics include special relativity, elementary quantum mechanics, the structure of matter, atoms, and nuclei, radioactivity, interactions of radiation with matter, and fundamental particles. Prerequisite(s): (PHY 208 or PHY 232) or permission of the chair of the physics department.

PHY 323. Computational Physics. 3 Hours
The course will explore how computers are used in physics. Topics will include simulations of physical systems, numerical analysis, and the use of mathematical analysis packages (MATHCAD, for example.) Programming will be done in True BASIC and MATHCAD. Prerequisite(s): MTH 218; (PHY 208 or PHY 232).

PHY 333. Digital & Analog Electronics for Scientists. 3 Hours
Basic concepts of digital and analog integrated circuit electronics are developed as a way to understand modern microcomputer based instrumentation. A microcomputer based data collection and analysis system is used to study binary data input and output, analog to digital conversion (ADC) devices, digital to analog conversion (DAC) devices, and other digital integrated circuits and concepts. The analog electronics part of the course begins with a study of discrete analog devices and ends with operational amplifiers and their application. Two hours lecture and two hour laboratories each week. Prerequisite(s): (PHY 202L or PHY 211L) or equivalent.

PHY 390. Introduction to Quantum Mechanics. 3 Hours
Basic postulates of quantum mechanics with applications made to atomic physics. Prerequisite(s): MTH 219; (PHY 208 or PHY 232). Corequisite(s): MTH 310.

PHY 395. Research Participation I. 1-6 Hours
Individual projects conducted as part of the physics Undergraduate Research Participation program to encourage involvement of students with faculty researchers. Projects must be arranged in advance with faculty research directors.

PHY 399. Special Problems in Physics. 1-4 Hours
Special topical courses, laboratory, tutorial, or library work in areas of current interest. Students should consult the composite.

PHY 403. Intermediate Mechanics II. 3 Hours
Emphasis on solving physical problems; noninertial coordinate systems, rigid body motion, rotating systems, coupled systems, introductory fluid statics and dynamics, normal coordinates, and the descriptions of mechanics appropriate for the transition to wave mechanics. Prerequisite(s): PHY 303.

PHY 404. Physical Optics. 3 Hours
The electromagnetic wave theory of light, propagation of waves, reflection, refraction, dispersion, polarization, birefringence, superposition of waves, interference, diffraction, Fourier optics. Prerequisite(s): MTH 219; (PHY 208 or PHY 232).

PHY 408. Intermediate Electricity & Magnetism I. 3 Hours
Electrostatics, Coulomb's law, Gauss's law, potential, dielectric materials, electrostatic energy, solutions to Laplace's and Poisson's equations, Biot-Savart law, Faraday induction law, magnetization, and Maxwell's equations. Prerequisite(s): MTH 219; (PHY 208 or PHY 232).

PHY 409. Intermediate Electricity & Magnetism II. 3 Hours
Further study of electric and magnetic fields with emphasis on solving problems; Maxwell's equations, propagation of electromagnetic waves, electromagnetic radiation. Prerequisite(s): PHY 408.

PHY 411. Topics in Modern Physics. 3 Hours
Elements of modern optics, solid state and other selected subjects. Consult chairperson for details. Prerequisite(s): PHY 390 or equivalent.

PHY 420. Introduction to Solid State. 3 Hours
Classification of solids, crystals and crystal structures, survey of lattice properties, free electron theory, band theory of solids, semi-conductors, and crystal imperfections. Prerequisite(s): MTH 219; (PHY 208 or 232); PHY 390.
PHY 430. Advanced Lab I. 2 Hours
First course in a two-semester laboratory sequence designed for upper-level undergraduate physics majors. Programming and use of data acquisition and analysis systems, analysis of experimental error and uncertainty, design and construction of experiments that combine mechanical, electrical, and optical components, documentation of laboratory procedures, and writing and presenting technical reports are emphasized. Prerequisite(s): PHY333, and (CPS132 or CPS150 or ECE203).

PHY 431. Advanced Lab II. 2 Hours
Second course in a two-semester laboratory sequence designed for upper-level undergraduate physics majors. Programming and use of data acquisition and analysis systems, design and construction of experiments that combine mechanical, electrical, and optical components, documentation of laboratory procedures, and writing and presenting technical reports are emphasized. Prerequisite(s): PHY 430.

PHY 440. Quantum Mechanics II. 3 Hours
Study of selected principles in quantum mechanics. Prerequisite(s): PHY 390.

PHY 450. Senior Project. 3 Hours
The senior project is a capstone experience for senior physics majors. It will consist of a research project of the student’s choosing and will require both an oral and written report. The nature and scope of the project will be chosen in consultation with the student’s advisor. Permission of the department chairperson is required. Senior physics majors only.

PHY 460. Seminar. 1 Hour
Presentation of papers by undergraduate students, faculty, and a guest lecturer on topics of concern to the modern physicist. Reviews of books and films appropriate to the group.

PHY 470. Introduction to Computational Physics. 3 Hours
Study of important problems in physics, other sciences, and engineering that require a numerical solution. This course refines computation skills by providing direct experience writing, executing and analyzing computer programs used to solve such problems. The approach in this course is intended to mimic approaches used in research. Prerequisite(s): MTH 219, PHY 208 or PHY 232.

PHY 477. Honors Thesis Project. 3 Hours
First of two courses leading to the selection, design, investigation, and completion of an independent, original Honors Thesis project under the guidance of a faculty research advisor. Restricted to students in the University Honors Program with permission of the program director and department chairperson. Students pursuing an interdisciplinary thesis topic may register for three semester hours each in two separate disciplines in consultation with the department chairpersons. Prerequisite(s): Approval of University Honors Program.

PHY 478. Honors Thesis Project. 3 Hours
Second of two courses leading to the selection, design, investigation, and completion of an independent, original Honors Thesis project under the guidance of a faculty research advisor. Restricted to students in the University Honors Program with permission of the program director and department chairperson. Students pursuing an interdisciplinary thesis topic may register for three semester hours each in two separate disciplines in consultation with the department chairpersons. Prerequisite(s): Approved 477; approval of University Honors Program.

PHY 480. Physics Capstone. 1 Hour
This seminar course is the capstone for all physics majors. Students will complete an independent research project and present their results in written form and in a presentation. Students will learn about the variety of career paths available after completing an undergraduate physics degree, and how to engage in these career paths in an ethical manner.

PHY 495. Research Participation II. 1-6 Hours
Individual projects conducted as part of the physics Undergraduate Research Participation program to encourage involvement of students with faculty researchers. Projects must be arranged in advance with faculty research directors.

PHY 499. Special Problems in Physics. 1-6 Hours
Laboratory, tutorial, or library work in one of such selected topics as solid state physics, polymers, atomic and nuclear physics, modern optics, theoretical physics, surface physics, or general physics. Prerequisite(s): Permission of department chairperson.