Department of Physics

www.physics.uni.edu

The Department of Physics offers the following programs:

Undergraduate Major (B.S.)

• Physics (p. 1)

Undergraduate Major (B.A.)

• Physics (p. 1)
• Physics-Teaching (p. 3)

Minors

• Data Science (p. 3) (also listed in Department of Computer Science and Department of Mathematics)
• Materials Science and Technology (p. 4) (also listed in Department of Chemistry and Biochemistry and Department of Applied Engineering & Technical Management)
• Nanoscience and Nanotechnology (p. 4)
• Physics (p. 4)

Program Certificate

• Physics Teaching (p. 5)

The Department of Physics offers major programs in two baccalaureate areas: the Bachelor of Science and the Bachelor of Arts. The B.S. Physics major is recommended for students who wish to prepare for graduate study in physics, engineering, or other sciences such as geophysics, astronomy, biophysics, or medical physics. The B.A. Physics major is ideal for a student with interdisciplinary interests who wishes to combine physics with courses from another area. The B.A. Physics-Teaching program provides students with the best qualification to teach physics in high school.

The dual-degree program in physics and engineering in cooperation with Iowa State University (ISU) is also offered. The first three years of coursework in liberal arts and physics B.S. are completed at UNI. During the fourth and fifth years, engineering courses are completed at ISU. When finished, a student will have a bachelor’s degree in Physics from UNI and bachelor’s degree in Engineering from ISU.

Bachelor of Science Degree Program

Emphasis-B.S. Physics Major Honors Research

Students who complete a sustained research project in physics may be invited to do Honors Research. Students must first complete 4 credit hours of PHYSICS 3000 Undergraduate Research in Physics and then 1 credit hour of PHYSICS 4990 Senior Thesis.

Physics Major

The B.S. Physics major requires a minimum of 120 total hours to graduate. This total includes UNIFI/General Education requirements and the following specified major requirements, plus electives to complete the minimum of 120 hours.

Note: To graduate with a B.S. degree in Physics, a student must earn an overall grade point average of at least 2.50 in all courses applied toward the major.

Required

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1420</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>MATH 1421</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 2422</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 1100</td>
<td>First-Year Projects in Physics</td>
<td>1</td>
</tr>
<tr>
<td>PHYSICS 1701</td>
<td>Physics I for Science and Engineering</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 1702</td>
<td>Physics II for Science and Engineering</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 2300</td>
<td>Physics III: Theory and Simulation</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 2700</td>
<td>Mathematical Methods of Physics &amp; Engineering</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 3000</td>
<td>Undergraduate Research in Physics @</td>
<td>2</td>
</tr>
<tr>
<td>or PHYSICS 3500</td>
<td>Internship in Applied Physics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 3700</td>
<td>Physics Seminar</td>
<td>1</td>
</tr>
<tr>
<td>PHYSICS 4100/5100</td>
<td>Modern Physics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 4110/5110</td>
<td>Modern Physics Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>PHYSICS 4300/5300</td>
<td>Introduction to Electronics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 4600/5600</td>
<td>Classical Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 4700/5700</td>
<td>Electrodynamics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 4860/5860</td>
<td>Computational Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 4900/5900</td>
<td>Thermodynamics and Statistical Mechanics</td>
<td>4</td>
</tr>
</tbody>
</table>

Electives

Physics, Natural Science, or Math Electives * | 4 |

Total Hours 59

* Electives must be mathematics or science courses that count toward a major of the department offering the course. Electives should be selected with the advice of an academic adviser in Physics.

@This course meets the Bachelor of Science degree undergraduate research requirement.

Bachelor of Arts Degree Program

Physics Major

The B.A. Physics Major is suitable for students who are interested in physics but are looking for a more interdisciplinary experience
than the B.S. Physics Major. Potential careers include, for example, computer science, data science, medicine, business, or law. The B.A. Physics Major requires a minimum of 120 total hours for graduation. This includes the major requirements and electives specified below, as well as UNIFI/General Education requirements.

The B.A. Physics major has three emphases: Custom Emphasis, Data Science Emphasis, and Physical Chemistry Emphasis. Students should choose one emphasis. Each emphasis requires completion of a common physics core, a common mathematics core and electives. The Data Science Emphasis has an additional core of data science-related courses and a required project.

**Custom Emphasis**

The Custom Emphasis is designed to combine a core understanding of physics with additional course work from other disciplines. The flexibility of this major makes it ideal for students interested in dual majors or one or more minors. The rigor of the program allows students to better prepare themselves for careers in any field, especially those related to science or technology. Students work with an advisor to create an individualized emphasis to best meet their needs.

Required Physics Core:

<table>
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<td>PHYSICS 4110/5110</td>
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Required Mathematics Core

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<td>Calculus II</td>
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Electives:

Elective requirements should be chosen from the following: (Other choices will need departmental approval)

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<tr>
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<tbody>
<tr>
<td>CS 1510</td>
<td>Introduction to Computing</td>
<td>3</td>
</tr>
<tr>
<td>GEOG 2410</td>
<td>Geographic Information Systems I</td>
<td>3</td>
</tr>
<tr>
<td>ACT SCI 3780/5780</td>
<td>Mathematics of Finance</td>
<td>3</td>
</tr>
<tr>
<td>STAT 3752/5752</td>
<td>Decision Analytics</td>
<td>3</td>
</tr>
<tr>
<td>STAT 3771/5771</td>
<td>Applied Statistical Methods for Research</td>
<td>3</td>
</tr>
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</table>

Total Hours: 42

* STAT 3775/5775 has the following: MATH 3752/5752 is a prerequisite; MATH 2422 is a pre-or-co-requisite.

**Data Science Emphasis**

The Data Science Emphasis integrates significant course work in physics, statistics and business analytics with electives from other areas such as Geographic Information Systems and computer programming. The goal is for students to develop broad-based skills in the analysis of data and the extraction of gainful information about a variety of systems.

Required Physics Core

<table>
<thead>
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**Required Mathematics Core**

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Required Data Science Core

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<tr>
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<tbody>
<tr>
<td>STAT 1772</td>
<td>Introduction to Statistical Methods</td>
<td>3</td>
</tr>
<tr>
<td>STAT 4772/5772</td>
<td>Statistical Computing I</td>
<td>3</td>
</tr>
<tr>
<td>ECON 1011</td>
<td>Statistics for Business Analytics</td>
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</tr>
<tr>
<td>ECON 2090</td>
<td>Decision Analytics</td>
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Required Data Science Project

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<tr>
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<tbody>
<tr>
<td>PHYSICS 3000</td>
<td>Undergraduate Research in Physics</td>
<td>1</td>
</tr>
<tr>
<td>or PHYSICS 3500</td>
<td>Internship in Applied Physics</td>
<td>1</td>
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</tbody>
</table>

Electives 3-4

Elective courses must count toward a major in the department that offers the course.

Mathematics courses must be higher level than MATH 1421.

Total Hours: 42-43

**Physical Chemistry Emphasis**

The Physical Chemistry Emphasis is intended to facilitate deeper study of physics by chemistry or biochemistry majors. The study of more-advanced physics topics will enhance problem-solving skills and promote greater understanding of chemistry and biochemistry though connections with quantum mechanics, electricity & magnetism, and classical mechanics studied in physics.

Required Physics Core

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Department of Physics
**Department of Physics**

**Required Chemistry Core:**
CHEM 1110  General Chemistry I  5-8
& CHEM 1120  and General Chemistry II
or CHEM 1130  General Chemistry I-I
CHEM 4420/5420  Physical Chemistry I  3
CHEM 4430/5430  Physical Chemistry II  3

**Advanced Laboratory:**
Choose one of the following
PHYSICS 4110/5110 Modern Physics Laboratory
CHEM 4440/5440  Physical Chemistry Laboratory  *

**Applied Physics:**
PHYSICS 4750/5750 Physics of Modern Materials
or PHYSICS 4500/5500 Biological Physics
or PHYSICS 4300/5300 Introduction to Electronics  3-4

**Electives:**
3000-level Physics or above (no more than 1 hour of
PHYSICS 3000 Undergraduate Research in Physics); or
3000-level Chemistry/Biochemistry or above (no more
than 1 hour of CHEM 3600 Undergraduate Research in
Chemistry)  2-3

**Total Hours**  42-47

* CHEM 4440/5440 has CHEM 2320 and CHEM 2330 as prerequisites

**Emphasis-B.A. Physics Major-Teaching Honors Research**
Students who complete a sustained research project in physics
education may be invited to do Honors Research. Students must first
complete 4 credit hours of PHYSICS 3000 Undergraduate Research in
Physics and then 1 credit hour of PHYSICS 4990 Senior Thesis.

**Physics Major-Teaching**
The B.A. Physics major in teaching requires a minimum of 120 total
hours to graduate. This total includes UNIFI/General Education
requirements, the Professional Education Requirements, and the
following specified major requirements, plus electives to complete the
minimum of 120 hours.

This major leads to endorsement #156: 5-12 Physics.

**Required**
Mathematics:
MATH 1420  Calculus I  4
MATH 1421  Calculus II  4

Science and Science Education:
SCI ED 3300/5300 Orientation to Science Teaching  4
SCI ED 4800/5800 Methods for Teaching Secondary Science or MTSS  3

Teaching:

**Electives**
Mathematics or non-physics science courses from the
College of Humanities, Arts and Sciences  4

**Total Hours**  46

* Excluding all 820:xxx and mathematics below MATH 1420.

It is recommended that sufficient work including current curricula
should be taken for licensure approval in a second area. Common
teaching combinations are physics-chemistry or physics-mathematics.

Completion of this major will satisfy the requirements of the Iowa
Department of Education for licensure.

**Minors**

**Data Science Minor**
The Data Science minor is an interdisciplinary program that integrates
computer programming, machine learning, statistics, predictive
modeling and visualization to provide students with broad based skills
for extracting gainful information from data that originate from a
variety of sources. A final project (ideally with corporate or non-profit
partnerships) will ensure that students employ their skills to solve a
real-world problem.

Statistics:
STAT 1772  Introduction to Statistical Methods  3
STAT 4784/5784  Introduction to Machine Learning  3

Computer Science:
CS 1510  Introduction to Computing  4
CS 2150  Computing for Data Science  3-7
or
CS 1520  Data Structures
& CS 1800  and Discrete Structures
CS 3140/5140  Database Systems  3

Physics:
PHYSICS 4160/5160  Data Visualization, Modeling
and Simulation  3

Required Data Science Project  2-3
Department of Physics

CS 4800 Undergraduate Research in Computer Science
or MATH 4990 Undergraduate Research in Mathematics
or PHYSICS 3000 Undergraduate Research in Physics

Total Hours 21-26

Materials Science and Technology Minor

This is an interdisciplinary minor that is jointly offered by the Departments of Chemistry and Biochemistry, Physics, and Applied Engineering & Technical Management.

Materials science and the use of materials in technology requires the use of concepts from multiple disciplines. This interdisciplinary minor gives students the broad foundation they need to learn about the science of materials and an introduction to how these scientific principles are used in the development and application of materials in new technology. This minor is complementary preparation to a major in Chemistry and Biochemistry, Physics or Manufacturing Engineering Technology for students who are interested in working in industry or going on to advanced study in materials science.

Required:
Choose one of the following three options: + 5-8

Option 1 Chemistry (8 hours)
CHEM 1110 General Chemistry I
CHEM 1120 General Chemistry II

OR
Option 2 Chemistry (5 hours)
CHEM 1130 General Chemistry I-II

OR
Option 3 Chemistry/Technology (7 hours)
CHEM 1020 Chemical Technology &
TECH 3127 Applied Thermodynamics &

Additional requirements (all three options)
Choose one of the following sets of Physics courses: 8
PHYSICS 1511 General Physics I
& PHYSICS 1512 and General Physics II

OR
PHYSICS 1701 Physics I for Science and Engineering
& PHYSICS 1702 and Physics II for Science and Engineering

Additional required (all three options)
CHEM 4200/5200 Nanoscience *
3

or PHYSICS 4200/5200 Nanoscience

TECH 2072 Engineering Materials 3

Electives (all three options) - choose one of the following: 3-4

Note: in order to earn the Materials Science and Technology minor, the elective course students take for the minor cannot be a required course for their primary major.

PHYSICS 1511 General Physics I
& PHYSICS 1512 and General Physics II (required)

Nanoscience and Nanotechnology Minor

Required
Chemistry and Biochemistry: 5-8
Select one of the following:
CHEM 1110 General Chemistry I
& CHEM 1120 and General Chemistry II

CHEM 1130 General Chemistry I-II

Physics:
PHYSICS 1511 General Physics I
or PHYSICS 1701 Physics I for Science and Engineering

PHYSICS 1512 General Physics II
or PHYSICS 1702 Physics II for Science and Engineering

PHYSICS 4200/5200 Nanoscience
or CHEM 4200/5200 Nanoscience

PHYSICS 4210/5210 Nanotechnology
or CHEM 4210/5210 Nanotechnology

Total Hours 19-22

Physics Minor

Required
Physics:
Select one of the following: 8

PHYSICS 1511 General Physics I
& PHYSICS 1512 and General Physics II
PHYSICS 1701 & PHYSICS 1702

Physics I for Science and Engineering and Physics II for Science and Engineering (required)

Electives: 12

Physics:

3000-level electives in Physics, with no more than 3 hours earned in the following:

PHYSICS 3000 Undergraduate Research in Physics (and/or)
PHYSICS 4450/5450 Laboratory Projects

Total Hours 20

* See course descriptions to reference 4-digit numbers associated with these 3000-level courses.

Program Certificate

The University of Northern Iowa makes available, in addition to traditional programs, the opportunity for students to earn program certificates. Program certificates provide an alternative to programs leading to a degree, a major, or a minor; they certify that an individual has completed a program approved by the university. For information on the following certificates, contact the Department of Physics or the Office of the Registrar, which serves as the centralized registry.

Physics Teaching Certificate

Completion of the certificate for the majors mentioned in the electives section below meets the requirements of endorsement #156: 5-12

Required:

Physics:

PHYSICS 1511 General Physics I 4
or PHYSICS 1701 Physics I for Science and Engineering
PHYSICS 1512 General Physics II 4
or PHYSICS 1702 Physics II for Science and Engineering
PHYSICS 4080/5080 Resources for Teaching Physics 2

Science Education:

SCI ED 3300/5300 Orientation to Science Teaching 4

Electives chosen from the following: 3-5

Elective hours vary by major program. Mathematics Teaching majors and Chemistry Teaching majors must select three hours from the following; other secondary science teaching majors including Comprehensive Secondary Science Teaching, Middle Level Science Teaching Dual, Biology Teaching, and Earth Science Teaching must select five hours from the following:

PHYSICS 1100 First-Year Projects in Physics
PHYSICS 2300 Physics III: Theory and Simulation
PHYSICS 3000 Undergraduate Research in Physics *
PHYSICS 3030 Robotics and Sensors
PHYSICS 4050/5050 Optical Science

PHYSICS 4100/5100 Modern Physics
PHYSICS 4110/5110 Modern Physics Laboratory
PHYSICS 4200/5200 Nanoscience
PHYSICS 4210/5210 Nanotechnology
PHYSICS 4290/5290 Project Lead The Way: Digital Electronics
PHYSICS 4300/5300 Introduction to Electronics

Total Hours 17-19

* A maximum of 2 hours are allowed.

Physics, B.S.

1. Apply Techniques of Experimental Physics
2. Understand Principles of Theoretical Physics
3. Apply Techniques of Computational Physics
4. Integrate and Apply Classroom Learning
5. Be Prepared for Employment or Graduate Study

A student who has earned a bachelor’s degree in physics from the University of Northern Iowa must demonstrate competence at the introductory (second-year) level in all three content areas (experimental, theoretical, and computational) through course-level outcomes aligned with each branch. A successful B.S. student must also acquire and demonstrate skills in career preparation as well as advanced knowledge in three areas: classical mechanics, thermodynamics and statistical mechanics, and computational physics.

Physics: Custom, B.A.

1. Apply Techniques of Experimental Physics
2. Understand Principles of Theoretical Physics
3. Apply Techniques of Computational Physics

A student with the Custom Emphasis must also acquire and demonstrate knowledge and understanding of physics beyond the introductory level.

Physics: Data Science, B.A.

1. Apply Techniques of Experimental Physics
2. Understand Principles of Theoretical Physics
3. Apply Techniques of Computational Physics

A student with the Data Science Emphasis must also meet learning outcomes of courses in statistics and data analytics taken outside of the Physics Department.
Physics: Physical Chemistry, B.A.
1. Apply Techniques of Experimental Physics
2. Understand Principles of Theoretical Physics
3. Apply Techniques of Computational Physics

A student who has earned a bachelor’s degree in physics from the University of Northern Iowa must demonstrate competence at the introductory level (second-year) in all three content areas (experimental, theoretical, and computational) through course-level outcomes aligned with each branch. A student with the Physical Chemistry Emphasis must also meet the learning outcomes of their chemistry courses.

Physics Teaching, B.A.
1. Apply Techniques of Experimental Physics
2. Understand Principles of Theoretical Physics
3. Apply Techniques of Computational Physics
4. Understand and Practice Modern Physics Pedagogy

A student who has earned a bachelor’s degree in physics from the University of Northern Iowa must demonstrate competence at the introductory (second-year) level in all three content areas (experimental, theoretical, and computational) through course-level outcomes aligned with each branch. A successful B.A. Physics Teaching student must also demonstrate knowledge and understanding of physics pedagogy. Competence in both content and pedagogy are necessary for the successful practice of high-school physics teaching.

Physics/Engineering Dual Degree Program, B.S.
1. Apply Techniques of Experimental Physics
2. Understand Principles of Theoretical Physics
3. Apply Techniques of Computational Physics
4. Integrate and Apply Classroom Learning
5. Be Prepared for Employment or Graduate Study

A student who has earned a bachelor’s degree in physics from the University of Northern Iowa must demonstrate competence at the introductory (second-year) level in all three content areas (experimental, theoretical, and computational) through course-level outcomes aligned with each branch. A successful B.S. student must also acquire and demonstrate skills in career preparation as well as advanced knowledge in three areas: classical mechanics, thermodynamics and statistical mechanics, and computational physics. A successful student in the dual-degree program must also demonstrate competence in engineering principles and practice according to the learning outcomes of the institution that houses the engineering program.