Description
The Department of Physics and Astronomy offers programs leading to the bachelor of arts and bachelor of science degrees. Students preparing for either graduate study or a professional career in physics should pursue the bachelor of science degree with a professional option. For students who have special interests, the department offers options in optics and lasers, materials physics, and computational physics.

The courses required for the bachelor of arts degree in physics offer a broader program in science and the liberal arts suitable for a variety of pre-professional curricula and for interdisciplinary studies in areas including biophysics, chemical physics, and geophysics.

College Requirements
College Admission
College Admission
The entrance requirements for the College of Arts and Sciences are the same as the UNL General Admission Requirements. Students who are admitted through the Admission by Review process may have certain conditions attached to their enrollment at UNL. These conditions are explained under “Removal of Deficiencies.”

In addition to these requirements, the College of Arts and Sciences strongly recommends a third and fourth year of one foreign language. Four years of high school coursework in the same language will fulfill the College of Arts and Sciences’ language requirement. It will also allow students to continue language study at a more advanced level at UNL, and provide more opportunity to study abroad.

Transfer Students
To be considered for admission as a transfer student, Nebraska resident or nonresident, students must have an accumulated average of C (2.0 on a 4.0 scale) and a minimum C average in the last semester of attendance at another college. Transfer students who graduated from high school January 1997 and after must also meet the UNL General Admission Requirements. Those transfer students who graduated before January 1997 must have completed in high school 3 years of English, 2 years of the same foreign language, 2 years of algebra, and 1 year of geometry. Transfer students who have completed less than 12 credit hours of college study must also submit either their ACT or SAT scores.

Ordinarily, hours earned at a similarly accredited college or university are applicable to the UNL degree. The College, however, will evaluate all hours submitted on an application for transfer, and reserves the right to accept or reject any of them, based upon its exclusion and restriction policies. Sixty is the maximum number of hours the University will accept from a two-year college or international institution. Transfer credit in the major or minor must be approved by the departmental advisor on a Request for Substitution Form to meet specific course requirements, group requirements, or course level requirements in the major or minor. At least half of the hours in the major field must be completed at the University regardless of the number of hours transferred.

The College of Arts and Sciences will accept no more than 15 semester hours of C- and D grades from other schools. The C- and D grades cannot be applied toward requirements for a major or minor. This policy does not apply to the transfer of grades from UNO or UNK to UNL. All D grades may be transferred from UNO or UNK, but they are not applicable to a major or minor.

Readmitted Students
UNL students who choose not to take courses for more than 2 consecutive terms, must reapply to UNL. Students readmitted to the College of Arts and Sciences will follow the requirements stated in the catalog for the academic year of readmission and re-enrollment as a degree-seeking student in Arts and Sciences. In consultation with advisors, a student may choose to follow a catalog for any academic year in which they are admitted to and enrolled as a degree-seeking student at UNL in the College of Arts and Sciences. Students must complete all degree requirements from a single catalog year. Beginning in 1990-1991, the catalog which a student follows for degree requirements may not be more than 10 years old at the time of graduation.

Admission Deficiencies/Removal of Deficiencies
Students must remove entrance deficiencies in geometry and foreign language as soon as possible, and before graduating from the College of Arts and Sciences. For questions and more information, students should consult a college advisor in the Academic and Career Advising Center in 107 Oldfather Hall.

Removing Foreign Language Deficiencies
Students must complete the second semester of a first year language sequence to clear the deficiency and the second semester of the second year language sequence to complete the college graduation requirement in language.

Removing Geometry Deficiencies
A deficiency of one year of geometry can be removed by taking high school geometry courses through an approved independent study program, or by completing a geometry course from an accredited community college or a four-year institution. Neither of these options will count for college credit.

College Degree Requirements
College Distribution Requirements
Bachelor of Arts or Bachelor of Science (16 hours + Language)
The College of Arts and Sciences distribution requirements are designed to further the purposes of liberal education by encouraging study in several different areas within the College. All requirements are in addition to University ACE requirements. A student may not use a single course to satisfy more than one of the following five distribution requirements. A student cannot use a single course to satisfy both an ACE outcome and a College distribution requirement. A student cannot use a course from their primary major to satisfy the Breadth Requirement (F), but may apply an ancillary requirement of the primary major or a course from their secondary major toward this requirement. Independent study or reading courses and internships cannot be used to satisfy distribution requirements. To see a complete list of excluded courses, run a degree audit through MyRED.

Courses from interdisciplinary programs will count in the same area as courses from the home/cross-listed department(s).

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDR A</td>
<td>Written Communication</td>
<td>3</td>
</tr>
</tbody>
</table>

Select from courses approved for ACE outcome 1.
CDR B and BL - Natural, Physical, and Mathematical Sciences with Lab

Select from biochemistry, biological sciences, chemistry, computer science, geology, meteorology, mathematics, physics and statistics. Must include one lab in the natural or physical sciences. Lab courses may be selected from biochemistry, biological sciences, chemistry, geology, meteorology and physics.

Some courses from geography and anthropology may also be used to satisfy the lab requirement above.¹

CDR C - Humanities

Select from classics, English, history, modern languages and literatures, philosophy, and religious studies.²

CDR D - Social Science

Select from: anthropology, communication studies, geography, political science, psychology, or sociology.³

CDR E - Language

Fulfilled by the completion of the 6-credit-hour second-year sequence in a single foreign language in one of the following departments: Classics and religious studies, modern languages and literatures, or anthropology. Instruction is currently available in Arabic, Chinese, Czech, French, German, Greek, Japanese, Latin, Omaha, Russian, and Spanish. A student who has completed the fourth-year level of one foreign language in high school is exempt from the language requirement.

CDR F - Additional Breadth

Select from: natural, physical and mathematical sciences (Area B), humanities (Area C), or social sciences (Area D). Cannot be a course from the primary major.

Credit Hours Subtotal: 16-32

¹ See degree audit or a College of Arts and Sciences advisor for approved geography and anthropology courses that apply as natural science.

² Language courses numbered 210 or below apply only for the foreign language requirement.

³ See degree audit or College of Arts and Sciences advisor for list of natural/physical science courses in anthropology, geography, and psychology that do not apply as social science.

Scientific Base

Bachelor of Science Only (60 hours)

The bachelor of science degree requires students to complete 60 hours in mathematical, physical and natural sciences. Approved courses for scientific base credit come from the following College of Arts and Sciences disciplines: actuarial science, anthropology (selected courses), astronomy, biochemistry (excluding BIOS 203), biological sciences (excluding BIOS 203), chemistry (excluding CHEM 101), computer science (excluding CSCE 10), geography (selected courses), geology, life sciences, mathematics (excluding courses below MATH 104), meteorology, microbiology, physics and statistics.

See your degree audit or a College of Arts and Sciences advisor for a complete list including individual classes that fall outside of the disciplines listed above. Up to 12 hours of scientific and technical courses offered by other colleges may be accepted toward this requirement with approval of a college advisor.

Foreign Languages/Language Requirement

Languages Exemption Policy

UNL and the College of Arts and Sciences will exempt or waive students from the UNL entrance requirement of two years of the same foreign language or from the College’s language distribution requirement based on documentation only. The following are the options and procedures for documentation:

High School Transcripts

For the University entrance requirement, students must show an official high school transcript with two or more years of the same foreign language.

For the College of Arts and Sciences College Distribution Requirement E-Language, students must show an official high school transcript with four or more years of the same foreign language in high school, or show evidence of graduation from a non-English-speaking foreign high school. Students whose native language is not English must show English as a Second Language study on an official high school transcript. Four years of ESL at the high school level (9th, 10th, 11th and 12th grades) will be the basis for a waiver of the CDR E Language requirement.

Proficiency Examination at UNL

For the University entrance requirement, students who do not have transcript documentation can request to take a proficiency exam in the language. (This is not the same test as the Modern Languages Placement Exam.) However, UNL will provide testing only in the languages it teaches. Currently, these languages are: Arabic, French, German, Spanish, Russian, Czech, Japanese, Chinese.

For the College of Arts and Sciences College Distribution Requirement E-Language, the Department of Modern Languages will oversee the test at the 202 level. If the student passes the test, the department will sign the College Request for Waiver form and indicate the level of proficiency. The form is then forwarded to the Arts and Sciences Advising Center for approval.

The Department of Modern Languages will oversee the test and provide written documentation to the Arts and Sciences Advising Center the level of proficiency passed.

Distance Education

For the University entrance requirement, students without transcript documentation who claim proficiency in a language not taught at UNL, have the option of seeking out a distance education program in languages. If the student completes the equivalent of 102 from an approved distance education program, the student will meet the UNL entrance requirement. The student must have the course work approved before he/she takes/completes the course as equivalent to 102 by a College advisor. The student then completes the course and has the distance education program send the transcript to the Admissions Office.

For the College of Arts and Sciences College Distribution Requirement E-Language, the student can seek out a distance education program and complete the equivalent of the 202-level course. The student must submit the request on the College Request for Substitution form and have the course work approved by a College advisor. The student then completes the course and has the distance education program send the transcript to the Admissions Office.

Third Language Option

If a student demonstrates knowledge of two foreign languages at the 102 level, the College of Arts and Sciences may consider waiving two semesters of the four semester College Distribution Requirement.
E-Languages requirement. If this waiver were granted, the student would then be required to complete 101 and 102 in another, 3rd foreign language at UNL.

**Minimum Hours Required for Graduation**
A minimum of 120 semester hours of credit is required for graduation from the College of Arts and Sciences. A total grade point average of at least 2.0 is required.

**Grade Rules**

**Restrictions on C- and D Grades**
The College will accept no more than 15 semester hours of C- and D grades from other schools except for UNO and UNK. No transfer C- and D grades can be applied toward requirements in a major or a minor. No UNL C- and D grades can be applied toward requirements in a major or a minor.

**Pass/No Pass Privilege**

**University regulations for the Pass/No Pass (P/N) privilege state:**

- The Pass/No Pass option is designed for your use by seeking to expand your intellectual horizons by taking courses in areas where you may have had minimal preparation.
- Neither the P nor the N grade contribute to your GPA.
- P is interpreted to mean C or above.
- A change to or from a Pass/No Pass may be made until mid-term (see academic calendar for specific dates per term).
- The Pass/No Pass or grade registration cannot conflict with the policy of the professor, department, college, or University governing the grading option.
- Changing to or from Pass/No Pass requires using the MyRED system to change the grading option or filing a Drop/Add form with the Office of the University Registrar, 107 Canfield Administration Building. After mid-term of the course, a student registered for Pass/No Pass cannot change to a grade registration unless the Pass/No Pass registration is in conflict with the policy of the professor, department, college, or University governing grading option.
- The Pass/No Pass or grade registration cannot conflict with the policy of the professor, department, college, or University governing the grading option.
- The Pass/No Pass grading option cannot be used for the removal of C- or D or F grades.

**Pass/No Pass privileges in the College of Arts and Sciences are extended to students according to the following additional regulations:**

- Pass/No Pass hours can count toward fulfillment of University ACE requirements and college distribution requirements up to the 24-hour maximum.
- Most Arts and Sciences departments and programs do not allow courses graded Pass/No Pass to apply to the major or minor. Students should refer to the department’s or program’s section of the catalog for clarification. By college rule, departments can allow up to 6 hours of Pass/No Pass in the major or minor.
- Departments may specify that certain courses of theirs can be taken only on a P/N basis.
- The college will permit no more than a total of 24 semester hours of P/N grades to be applied toward degree requirements. This total includes all Pass grades earned at UNL and other U.S. schools. **NOTE:** This 24-hour limit is more restrictive than the University regulation.

**Grading Appeals**
A student who feels that he/she has been unfairly graded must ordinarily take the following sequential steps in a timely manner, usually by initiating the appeal in the semester following the awarding of the grade:

1. Talk with the instructor concerned. Most problems are resolved at this point.
2. Talk to the instructor’s department chairperson.
3. Take the case to the Grading Appeal Committee of the department concerned. The Committee should be contacted through the department chairperson.
4. Take the case to the College Grading Appeals Committee by contacting the Dean’s Office, 1223 Oldfather Hall.

**Course Level Requirements**

**Courses Numbered above 299**
Thirty of the 120 semester hours of credit must be in courses numbered above 299. Of the 30 hours above 299, 15 hours (1/2) must be completed in residence at UNL.

**Graduate Courses**
Seniors in the University who have obtained in advance the approval of the dean for Graduate Studies may receive up to 12 hours credit for graduate courses taken in addition to the courses necessary to complete their undergraduate work, provided that such credits are earned within the calendar year prior to receipt of the baccalaureate. For procedures, inquire at the Office of Graduate Studies.

Course work taken prior to receipt of the baccalaureate may not always be accepted for transfer to other institutions as graduate work.

**Residency**

**Residency Requirement and Open Enrollment and Summer Independent Study Courses**
Students must complete at least 30 of the 120 total hours for their degree at UNL. Students must complete at least 1/2 of their major coursework including 6 hours above 299 in their major, and 15 of the 30 hours required above 299 in residence. Credit earned during education abroad may be used toward the residency requirement if students register through UNL and participate in prior-approved education abroad programs. UNL open enrollment and summer independent study courses count toward residence.

**ACE Requirements**
Consistent with the mission and values of the University, ACE is based on a shared set of four institutional objectives and ten student learning outcomes. The ACE program was approved by faculty in all eight undergraduate colleges and endorsed by the Faculty Senate, the student government, and the Academic Planning Committee in January 2008 for implementation in the fall 2009. ACE aligns with current national initiatives in general education.

Key characteristics of ACE demonstrate the benefits of the program to students:

- Students receive a broad education with exposure to multiple disciplines, critical life skills and important reasoning, inquiry, and civic capacities.
- ACE is simple and transparent for students, faculty and advisors.
- Students complete the equivalent of 3 credit hours for each of the ten student learning outcomes.
- Students connect and integrate their ACE experiences with their selected major.
- Students can transfer all ACE certified courses across colleges within the institution to meet the ACE requirement and any course from outside the institution that is directly equivalent to a UNL ACE-certified course. Courses from outside institutions without direct equivalents may be considered with appropriate documentation for ACE credit (see academic advisor).

ACE allows faculty to assess and improve their effectiveness and facilitate students’ learning.

ACE Institutional Objectives and Student Learning Outcomes
To meet the ACE Program requirement, a student will complete a minimum of 3 credit hours for each of the ten ACE Student Learning Outcomes (a total of 30 ACE credit hours). See the ACE website at: http://ace.unl.edu for the most current information and the most recently certified courses.

Catalog Rule
Students must fulfill the requirements stated in the catalog for the academic year in which they are first admitted to and enrolled as a degree-seeking student at UNL. In consultation with advisors, a student may choose to follow a subsequent catalog for any academic year in which they are admitted to and enrolled as a degree-seeking student at UNL in the College of Arts and Sciences. Students must complete all degree requirements from a single catalog year. Beginning in 1990-1991 the catalog which a student follows for degree requirements may not be more than 10 years old at the time of graduation.

Learning Outcomes
Majors in physics will be able to:

1. Demonstrate a conceptual understanding of the fundamental principles of physics.
2. Properly invoke these principles in the explanation of physical phenomena.
3. Apply these principles in the solution of problems.
4. Content, stipulated in individual course syllabi, will include, though not be limited to: the principles of force and motion and the relationships between them, the conservation, transfer, and transformations of energy, the fundamental electric and magnetic properties of matter, the fundamental properties of mechanical and electromagnetic waves, the laws of thermodynamics, and the basic application and extension of all these principles to nuclear and atomic physics.

Major Requirements

Bachelor of Science

Core Requirement

Required courses – listed in the recommended sequence

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 201</td>
<td>Modern Topics in Physics and Astronomy</td>
<td>1</td>
</tr>
<tr>
<td>MATH 106</td>
<td>Calculus I</td>
<td>5</td>
</tr>
<tr>
<td>PHYS 211</td>
<td>General Physics I</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 221</td>
<td>General Physics Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>MATH 107</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 212</td>
<td>General Physics II</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 222</td>
<td>General Physics Laboratory II</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 113</td>
<td>Fundamental Chemistry I</td>
<td>4</td>
</tr>
</tbody>
</table>

Total Credit Hours Subtotal: 18

Optics and Lasers Option

The Optics and Lasers Option is designed for students intending to pursue graduate study or employment in optical or laser physics or in related engineering disciplines.

Optics and Lasers Option Required courses – listed in the recommended sequence

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 343</td>
<td>Physics of Lasers and Modern Optics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 361</td>
<td>Concepts of Modern Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 391</td>
<td>Undergraduate Research</td>
<td></td>
</tr>
<tr>
<td>PHYS 401</td>
<td>Computational Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 422</td>
<td>Introduction to Physics and Chemistry of</td>
<td></td>
</tr>
<tr>
<td>ECEN 422</td>
<td>Solids</td>
<td></td>
</tr>
<tr>
<td>PHYS 443</td>
<td>Experimental Physics III</td>
<td></td>
</tr>
<tr>
<td>PHYS 480</td>
<td>Introduction to Lasers and Laser</td>
<td></td>
</tr>
<tr>
<td>ECEN 480</td>
<td>Applications</td>
<td></td>
</tr>
<tr>
<td>ASTR 403</td>
<td>Galactic and Extragalactic Astronomy</td>
<td></td>
</tr>
<tr>
<td>ASTR 404</td>
<td>Stellar Astrophysics</td>
<td></td>
</tr>
<tr>
<td>ASTR 405</td>
<td>Physics of the Solar System</td>
<td></td>
</tr>
<tr>
<td>ASTR 407</td>
<td>Physics of the Interstellar Medium</td>
<td></td>
</tr>
<tr>
<td>MATH 314</td>
<td>Linear Algebra</td>
<td></td>
</tr>
<tr>
<td>or MATH 421</td>
<td>Introduction to Partial Differential</td>
<td></td>
</tr>
</tbody>
</table>

Total Credit Hours: 18

Specific Major Requirements

Complete the courses for one of the following options: Professional, Optics and Lasers, Materials Physics, or Computational Physics.

Professional Option

The Professional Option is designed for students intending to pursue graduate study or employment in physics or a related scientific or engineering discipline.

Professional Option Required Courses – listed in the recommended sequence

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 441</td>
<td>Experimental Physics I</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 442</td>
<td>Experimental Physics II</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 452</td>
<td>Optics and Electromagnetic Waves</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 462</td>
<td>Atoms, Nuclei, and Elementary Particles</td>
<td>3</td>
</tr>
</tbody>
</table>

Select at least 6 hours of the following:

<table>
<thead>
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<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 343</td>
<td>Physics of Lasers and Modern Optics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 361</td>
<td>Concepts of Modern Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 391</td>
<td>Undergraduate Research</td>
<td></td>
</tr>
<tr>
<td>PHYS 401</td>
<td>Computational Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 422</td>
<td>Introduction to Physics and Chemistry of</td>
<td></td>
</tr>
<tr>
<td>ECEN 422</td>
<td>Solids</td>
<td></td>
</tr>
<tr>
<td>PHYS 443</td>
<td>Experimental Physics III</td>
<td></td>
</tr>
<tr>
<td>PHYS 480</td>
<td>Introduction to Lasers and Laser</td>
<td></td>
</tr>
<tr>
<td>ECEN 480</td>
<td>Applications</td>
<td></td>
</tr>
<tr>
<td>ASTR 403</td>
<td>Galactic and Extragalactic Astronomy</td>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>MATH 314</td>
<td>Linear Algebra</td>
<td></td>
</tr>
<tr>
<td>or MATH 421</td>
<td>Introduction to Partial Differential</td>
<td></td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 18

Materials Physics Option

The Materials Physics Option is designed for students intending to pursue graduate study or employment in materials physics or in related engineering disciplines.

Materials Physics Option Required courses – listed in the recommended sequence

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 343</td>
<td>Physics of Lasers and Modern Optics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 441</td>
<td>Experimental Physics I</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 452</td>
<td>Optics and Electromagnetic Waves</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credit Hours: 18

Computational Physics Option

The Computational Physics Option is designed for students intending to pursue graduate study or employment in computational physics or in related engineering disciplines.

Computational Physics Option Required courses – listed in the recommended sequence

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 343</td>
<td>Physics of Lasers and Modern Optics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 441</td>
<td>Experimental Physics I</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 452</td>
<td>Optics and Electromagnetic Waves</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credit Hours: 18
**Materials Physics Option**
The Materials Physics Option is designed for students intending to pursue graduate study or employment in materials physics or in related disciplines.

**Materials Physics Option Required courses – listed in the recommended sequence**
<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 114 Fundamental Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 221 Elementary Quantitative Analysis</td>
<td>4</td>
</tr>
<tr>
<td>MATL 360 Elements of Materials Science</td>
<td>4</td>
</tr>
<tr>
<td>MATL 462 X-ray Diffraction</td>
<td>3</td>
</tr>
<tr>
<td>or MATL 471 Electron Microscopy of Materials</td>
<td></td>
</tr>
<tr>
<td>PHYS 422 / ECEN 422 Introduction to Physics</td>
<td>3</td>
</tr>
<tr>
<td>and Chemistry of Solids</td>
<td></td>
</tr>
</tbody>
</table>

Select at least 3 hours of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 391 Undergraduate Research</td>
<td></td>
</tr>
<tr>
<td>or PHYS 211 General Physics I</td>
<td></td>
</tr>
<tr>
<td>or PHYS 222 General Physics Laboratory I</td>
<td></td>
</tr>
<tr>
<td>or PHYS 211 General Physics I (preferred)</td>
<td></td>
</tr>
</tbody>
</table>

**Credit Hours Subtotal:** 20

**Total Credit Hours:** 20

1 Up to 3 hours of PHYS 391 may be counted toward these 3 hours by substitution, provided that the research project is approved by the advisor.

**Computational Physics Option**
The Computational Physics Option is designed for students intending to pursue graduate study or employment in computational physics or in related disciplines.

**Computational Physics Option Required courses – listed in the recommended sequence**
<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 156 Computer Science II</td>
<td>4</td>
</tr>
<tr>
<td>CSCE 251 Unix Programming Environment</td>
<td>1</td>
</tr>
<tr>
<td>or CSCE 252A FORTRAN Programming</td>
<td></td>
</tr>
<tr>
<td>PHYS 401 Computational Physics</td>
<td>3</td>
</tr>
</tbody>
</table>

Select at least 6 hours of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 391 Undergraduate Research</td>
<td></td>
</tr>
<tr>
<td>or CSCE 235 Introduction to Discrete Structures</td>
<td></td>
</tr>
<tr>
<td>or CSCE 310 Data Structures and Algorithms</td>
<td></td>
</tr>
<tr>
<td>or CSCE 440 / MATH 440 Numerical Analysis I</td>
<td></td>
</tr>
<tr>
<td>or CSCE 456 Parallel Programming</td>
<td></td>
</tr>
<tr>
<td>PHYS 343 Physics of Lasers and Modern Optics</td>
<td></td>
</tr>
<tr>
<td>PHYS 441 Experimental Physics I</td>
<td></td>
</tr>
</tbody>
</table>

**Credit Hours Subtotal:** 17

**Total Credit Hours:** 17

1 Up to 3 hours of PHYS 391 may be counted toward these 6 hours by substitution, provided that the research project is approved by the advisor.

**Bachelor of Arts Core Requirements**
The BA course requirements are designed for students pursuing careers for which the knowledge and methodology of physics are essential.

**Required courses – listed in the recommended sequence**
<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 201 Modern Topics in Physics and Astronomy</td>
<td>1</td>
</tr>
<tr>
<td>MATH 106 Calculus I</td>
<td>5</td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 211 General Physics I</td>
<td></td>
</tr>
<tr>
<td>&amp; PHYS 221 General Physics Laboratory I</td>
<td></td>
</tr>
<tr>
<td>or PHYS 141 Elementary General Physics I</td>
<td></td>
</tr>
<tr>
<td>MATH 107 Calculus II</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 113 Fundamental Chemistry I (preferred)</td>
<td></td>
</tr>
<tr>
<td>or CHEM 111 Chemistry for Engineering and Technology</td>
<td></td>
</tr>
<tr>
<td>or CHEM 106 General Chemistry I</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Course</th>
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<tr>
<td>PHYS 212 General Physics II</td>
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<td>&amp; PHYS 222 General Physics Laboratory II</td>
<td></td>
</tr>
<tr>
<td>(preferred)</td>
<td></td>
</tr>
<tr>
<td>or PHYS 142 Elementary General Physics II</td>
<td></td>
</tr>
<tr>
<td>MATH 208 Calculus III</td>
<td></td>
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<tr>
<td>PHYS 213 General Physics III</td>
<td></td>
</tr>
<tr>
<td>PHYS 223 General Physics Laboratory III</td>
<td></td>
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<tr>
<td>MATH 221 Differential Equations</td>
<td></td>
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<tr>
<td>PHYS 231 Electrical and Electronic Circuits</td>
<td></td>
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<tr>
<td>PHYS 311 Mechanics</td>
<td></td>
</tr>
<tr>
<td>PHYS 361 Concepts of Modern Physics</td>
<td></td>
</tr>
<tr>
<td>PHYS 441 Experimental Physics I</td>
<td></td>
</tr>
</tbody>
</table>

**Credit Hours Subtotal:** 48

**Specific Major Requirements**

**Additional Physics Courses**
Select 6 hours from the following:  
PHYS 343 Physics of Lasers and Modern Optics  
PHYS 391 Undergraduate Research  
PHYS 451 Electromagnetic Theory  
PHYS 461 Quantum Mechanics  
PHYS 431 Thermal Physics  
PHYS 480 Introduction to Lasers and Laser Applications  

Credit Hours Subtotal: 6

Additional Related Courses
Select 6 hours of math, statistics, engineering or science courses at the 300 or 400 level  
Credit Hours Subtotal: 6

Total Credit Hours 12

Additional Major Requirements
Grade Rules
C- and D Grades
A grade of C or above is required for all courses in the major and minor.

Pass/No Pass
No course taken Pass/No Pass will be counted toward the major or minor.

Requirements for Minor Offered by Department
Plan A Minor (19 hours)
PHYS 201 Modern Topics in Physics and Astronomy 1
Select one of the following sequences: 10
   PHYS 211 General Physics I  
   & PHYS 221 and General Physics Laboratory I  
   & PHYS 212 and General Physics II  
   & PHYS 222 and General Physics Laboratory II  
or PHYS 141 Elementary General Physics I  
   & PHYS 142 and Elementary General Physics II  
PHYS 213 General Physics III 4  
PHYS 223 General Physics Laboratory III 1
Select one of the following: 3-4
   3 additional hours chosen from physics courses listed as requirements for the major in physics  
   ASTR 204 Introduction to Astronomy and Astrophysics  
   & ASTR 224 and Astronomy and Astrophysics Laboratory

Total Credit Hours 19

Plan B Minor (15 hours)
PHYS 201 Modern Topics in Physics and Astronomy 1
Select one of the following options: 10
   PHYS 211 General Physics I  
   & PHYS 221 and General Physics Laboratory I  
   & PHYS 212 and General Physics II  
   & PHYS 222 and General Physics Laboratory II  
or PHYS 141 Elementary General Physics I  
   & PHYS 142 and Elementary General Physics II  
PHYS 213 General Physics III 4  
Total Credit Hours 15

Grade Rules
C- and D Grades
A grade of C or above is required for all courses in the major and minor.

Pass/No Pass
No course taken Pass/No Pass will be counted toward the major or minor.

ASTR 103 Descriptive Astronomy
Description: Approach is essentially nonmathematical. Survey of the nature and motions of the planets, the sun, the stars, and their lives, galaxies, and the structure of the universe. Black holes, pulsars, quasars, and other objects of special interest included.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: ASTR 113; ASTR 203
ACE: ACE 4 Science

ASTR 103H Honors: Descriptive Astronomy
Prerequisites: Good standing in the University Honors Program or by invitation
Notes: Broad look at astronomy for non-science majors.
Description: Approach is essentially non-mathematical, but simple algebra is employed where appropriate. Sun and solar system, the stars, galaxies, and cosmology. Black holes, pulsars, quasars, and other objects of special interest included. Emphasis on both "what is out there" and "how we know it".
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: ASTR 113; ASTR 203
ACE: ACE 4 Science

ASTR 113 Selected Topics in Astronomy
Prerequisites: ASTR 103 or permission.
Description: A non-mathematical continuation and extension of ASTR 103, designed for students who would like a more detailed look at specific areas in astronomy. Possible topics: astronomy and relativity; life in the universe; pulsars, quasars, and black holes; evolution of galaxies, origin of the universe.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
ACE: ACE 4 Science
ASTR 117 Life in the Universe
Crosslisted with: BIOS 117, GEOL 117
Description: Survey of what modern science tells us about the possibilities of life elsewhere in the universe. Topics include how the Earth formed and became suitable for life, how life arose on the Earth, the conditions under which life can thrive, places in the solar system that might support life, the existence of other solar systems that might provide suitable habitats, and attempts to find evidence of life on other planets.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
ACE: ACE 4 Science

ASTR 203 Introduction to Observational Astronomy
Prerequisites: ASTR 103/103H or equivalent
Notes: The course consists of 2 lecture hours and three evening laboratory hours per week.
Description: Exploration of equipment and techniques needed to observe and investigate the motions and objects in the night sky.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC

ASTR 204 Introduction to Astronomy and Astrophysics
Prerequisites: PHYS 211/211H; MATH 107/107H; parallel ASTR 224
Notes: Survey of the sun, the solar system, stellar properties, stellar systems, interstellar matter, galaxies, and cosmology.
Description: Survey of the sun, the solar system, stellar properties, stellar systems, interstellar matter, galaxies, and cosmology.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
ACE: ACE 4 Science

ASTR 224 Astronomy and Astrophysics Laboratory
Prerequisites: Parallel ASTR 204.
Description: Telescopic observations and laboratory experiments relating to observational astronomy. Obtaining digital astronomical images, the analysis of the resulting data and its astrophysical interpretation.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LAB

ASTR 403 Galactic and Extragalactic Astronomy
Crosslisted with: ASTR 803
Prerequisites: ASTR 204 and PHYS 213, and permission.
Description: Introduction to the techniques for determining constituents and dynamics of our galaxy, including interstellar matter and theories of spiral arm formation. Extragalactic topics include basic characteristics of galaxies, active galaxies, quasars, evolution, and the cosmological distance scale.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

ASTR 404 Stellar Astrophysics
Crosslisted with: ASTR 804
Prerequisites: ASTR 204; PHYS 213; and permission.
Description: Stellar atmospheres, interiors, and evolution. Theoretical and observational aspects of stellar astronomy. The relation between observed parameters and theoretical parameters, star formation, stellar energy generation, and degenerate stars.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

ASTR 405 Physics of the Solar System
Crosslisted with: ASTR 805
Prerequisites: ASTR 204; MATH 107/107H; PHYS 142/142H or 212/212H.
Description: Celestial mechanics; tidal effects; planetary interiors; atmospheres and surfaces; comets; asteroids; and the origin of the solar system. Applying physics to the solution of solar system problems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

ASTR 407 Physics of the Interstellar Medium
Crosslisted with: ASTR 807
Prerequisites: ASTR 204 and PHYS 213.
Description: Gaseous nebulae, interstellar dust, interstellar clouds and star forming regions. Theoretical and observational aspects of the various components of the interstellar medium. Includes the physics of emission nebulae, the properties of the interstellar dust, interstellar molecules and the properties of clouds in which star formation occurs.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

ASTR 498 Special Topics
Crosslisted with: ASTR 898
Prerequisites: ASTR 204 and permission.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 9
Format: LEC

PHYS 115 Descriptive Physics
Description: Qualitative approach to physics for the non-science major that emphasizes concepts and how they are used to understand the everyday physical world. Newton's description of motion and forces, the atomic view of matter, kinds and transformations of energy, the nature of electricity and magnetism, sound and light waves, and subatomic particles. Some topics selected according to student interest. Recommended for all students wanting a nonmathematical look at basic discoveries of physics.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
ACE: ACE 4 Science
PHYS 141 Elementary General Physics I
Prerequisites: MATH 102 or higher; or qualifying score on Math Placement Exam for 106 or higher.
Notes: Credit toward the degree may be earned in only one of: PHYS 141, 141H, and 151. Lab fee required.
Description: Mechanics, heat, waves and sound.
Credit Hours: 5
Max credits per semester: 5
Max credits per degree: 5
Format: LEC
Prerequisite for: MSYM 232; MSYM 262; MSYM 452, MSYM 852, WATS 452, AGRO 452
ACE: ACE 4 Science

PHYS 141H Honors: Elementary General Physics I
Prerequisites: Good standing with the University Honors Program; MATH 102 or higher; or qualifying score on Math Placement Exam for 106 or higher.
Notes: Credit toward the degree may be earned in only one of: PHYS 141, 141H, and 151. Lab fee required.
Description: For course description, see PHYS 141.
Credit Hours: 5
Max credits per semester: 5
Max credits per degree: 5
Format: LEC
Prerequisite for: MSYM 262; MSYM 452, MSYM 852, WATS 452, AGRO 452
ACE: ACE 4 Science

PHYS 142 Elementary General Physics II
Prerequisites: PHYS 141 or 141H.
Description: Continuation of PHYS 141. Electricity, magnetism, optics, relativity, atomic and nuclear physics.
Credit Hours: 5
Max credits per semester: 5
Max credits per degree: 5
Format: LEC
Prerequisite for: GEOL 344; PHYS 343
ACE: ACE 4 Science

PHYS 142H Honors: Elementary General Physics II
Prerequisites: Good standing in the University Honors program or by invitation; PHYS 141 or 141H.
Notes: Lab fee required.
Description: For course description, see PHYS 142.
Credit Hours: 5
Max credits per semester: 5
Max credits per degree: 5
Format: LEC
Prerequisite for: GEOL 344; PHYS 343
ACE: ACE 4 Science

PHYS 151 Elements of Physics
Prerequisites: MATH 102 or higher; or qualifying score on Math Placement Exam for 106 or higher.
Notes: Credit toward the degree may be earned in only one of: PHYS 141, 141H, and 151.
Description: Short course, without laboratory, for those who need one semester of elementary general physics. Emphasis on understanding our physical environment through application of principles of mechanics, heat, sound, electricity, and light.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Prerequisite for: CNST 306; MSYM 109L; MSYM 232; MSYM 262; MSYM 452, MSYM 852, WATS 452, AGRO 452
ACE: ACE 4 Science

PHYS 153 Elements of Physics Laboratory
Prerequisites: PHYS 151 or parallel.
Notes: Optional lab to accompany PHYS 151.
Description: Laboratory experiments in mechanics, heat, and wave motion.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LAB
Prerequisite for: CNST 306

PHYS 198 Special Topics in Physics
Description: Topic varies.
Credit Hours: 1-6
Min credits per semester: 1
Max credits per semester: 6
Max credits per degree: 6
Format: LEC

PHYS 201 Modern Topics in Physics and Astronomy
Prerequisites: Must be a PHYS major or minor with freshman or sophomore status.
Description: Seminar/workshop that introduces students to topics in modern physics research in basic and applied areas. Students given an understanding of how their studies relate to current progress in physics and astronomy and to prepare for careers in physics-related disciplines.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LEC

PHYS 211 General Physics I
Prerequisites: One year high school physics or PHYS 141 or 141H or 151 or permission; MATH 106 or parallel
Description: Calculus-based course intended for students in engineering and the physical sciences. Mechanics, fluids, wave motion, and heat.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Prerequisite for: AREN 211; ASTR 204; BSEN 244; BSEN 317; ECEN 211; MECH 223; MECH 250; METR 205; METR 323; MSYM 232, MSYM 262, PHYS 212; PHYS 212H, PHYS 221
ACE: ACE 4 Science
PHYS 211H Honors: General Physics I  
**Prerequisites:** Physics major or good standing with the University Honors Program; MATH 106 or parallel.  
**Description:** For course description, see PHYS 211.  
**Credit Hours:** 4  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC  
**Prerequisite for:** AREN 211; ASTR 204; BSEN 244; BSEN 317; ECEN 211; MECH 223; MECH 250; METR 205; METR 323; MSYM 232; MSYM 262; PHYS 212; PHYS 212H; PHYS 221; PHYS 222  
ACE: ACE 4 Science  

PHYS 211 General Physics I  
**Prerequisites:** PHYS 211 or 211H; MATH 106 or parallel.  
**Description:** For course description, see PHYS 211.  
**Credit Hours:** 4  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC  

PHYS 212 General Physics II  
**Prerequisites:** PHYS 211 or 211H; MATH 107 or 107H or parallel.  
**Description:** Continuation of PHYS 211. Electricity, magnetism, and optics.  
**Credit Hours:** 4  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC  
**Prerequisite for:** AGEN 325, BSEN 325; ECEN 306; GEOL 344; MATL 360; MECH 421, MECH 821, ENGR 421; PHYS 213; PHYS 213H; PHYS 222; PHYS 311; PHYS 343  
ACE: ACE 4 Science  

PHYS 212H Honors: General Physics II  
**Prerequisites:** Physics major or good standing with the University Honors Program; PHYS 211 or 211H; MATH 107 or 107H or parallel.  
**Notes:** Ambitious students who are not in the Honors Program are encouraged to request permission to enroll.  
**Description:** For course description, see PHYS 212.  
**Credit Hours:** 4  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC  
**Prerequisite for:** AGEN 325, BSEN 325; ECEN 306; GEOL 344; MATL 360; MECH 421, MECH 821, ENGR 421; PHYS 213; PHYS 213H; PHYS 222; PHYS 311; PHYS 343  
ACE: ACE 4 Science  

PHYS 211 General Physics Laboratory I  
**Prerequisites:** PHYS 211 or 211H or parallel.  
**Notes:** Optional lab to accompany PHYS 211.  
**Description:** Experiments in mechanics, heat and wave motion.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Format:** LAB  
**Prerequisite for:** PHYS 211  

PHYS 212 General Physics Laboratory II  
**Prerequisites:** PHYS 212 or 212H or parallel.  
**Notes:** Optional lab to accompany PHYS 212.  
**Description:** Laboratory experiments in electromagnetism and optics.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Format:** LAB  
**Prerequisite for:** PHYS 212  

PHYS 213 General Physics Laboratory III  
**Prerequisites:** PHYS 212 and 222.  
**Description:** Diode, transistor, and operational amplifier circuits and analog applications; gates, flip-flops, and elementary digital electronics.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC  
**Prerequisite for:** PHYS 223  

PHYS 221 General Physics Laboratory I  
**Prerequisites:** PHYS 211 or 211H or parallel.  
**Notes:** Optional lab to accompany PHYS 211.  
**Description:** Experiments in mechanics, heat and wave motion.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Format:** LAB  
**Prerequisite for:** PHYS 211  

PHYS 222 General Physics Laboratory II  
**Prerequisites:** PHYS 212 or 212H or parallel.  
**Notes:** Optional lab to accompany PHYS 212.  
**Description:** Laboratory experiments in electromagnetism and optics.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Format:** LAB  
**Prerequisite for:** PHYS 212  

PHYS 223 General Physics Laboratory III  
**Prerequisites:** PHYS 213 or 213H or parallel.  
**Description:** Experiments in atomic and nuclear physics.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Format:** LAB  
**Prerequisite for:** PHYS 213  
ACE: ACE 4 Science  

PHYS 231 Electrical and Electronic Circuits  
**Prerequisites:** PHYS 212 and 222.  
**Description:** Basic concepts of physics in a historical context and in relationship to the intellectual development of humankind. Mechanics, heat gravitation, and structure of the universe.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC  
**Prerequisite for:** PHYS 262  
ACE: ACE 4 Science  

PHYS 260 Liberal Arts Physics: Matter and Motion  
**Prerequisites:** MATH 101 or higher; or qualifying score on Math Placement Exam for MATH 102, 104, or higher.  
**Description:** Basic concepts of physics in a historical context and in relationship to the intellectual development of humankind. Mechanics, heat gravitation, and structure of the universe.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC  
**Prerequisite for:** PHYS 262  
ACE: ACE 4 Science  

PHYS 261 Liberal Arts Physics: Atoms and Fields  
**Prerequisites:** MATH 101 or higher; or qualifying score on Math Placement Exam for MATH 102, 104, or higher.  
**Description:** Basic concepts of physics in a historical context and in relationship to the intellectual development of humankind. Atomic structure of matter, states of matter, waves, and light. Practical consequences of the properties of matter and physical phenomena.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC  
**Prerequisite for:** PHYS 262  
ACE: ACE 4 Science
PHYS 262 Physical Sciences by Inquiry
Prerequisites: PHYS 260 or PHYS 261 or parallel.
Notes: Intended for students planning to be elementary or middle-level teachers
Description: Selected physical science concepts using inquiry methods.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LAB

PHYS 298 Special Topics in Physics
Prerequisites: Permission.
Credit Hours: 1-12
Min credits per semester: 1
Max credits per semester: 12
Max credits per degree: 12
Format: LEC

PHYS 311 Mechanics
Prerequisites: PHYS 212 or 212H or parallel, MATH 221 or 221H or parallel.
Description: Review of vector operations and of the kinematics and dynamics of a particle. Dynamics of a system of particles, motion of rigid bodies, central force problems, collisions, Lagrangian techniques, oscillations, and coupled oscillators.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

PHYS 343 Physics of Lasers and Modern Optics
Prerequisites: PHYS 142 or 142H or 212 or 212H.
Description: Physical principles and techniques of lasers and modern optics. Emphasis on practical experience with state-of-the-art techniques and applications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

ACE: ACE 10 Integrated Product

PHYS 361 Concepts of Modern Physics
Prerequisites: PHYS 142 or 212 with a grade of C+ or better.
Description: Some of the concepts and ideas underlying modern areas of physics through readings from non-technical works by noted physicists and science writers. Includes quantum mechanics, relativity, cosmology, chaos, and examples of modern technology.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

ACE: ACE 10 Integrated Product

PHYS 399H Honors Course
Prerequisites: Permission.
Credit Hours: 1-4
Min credits per semester: 1
Max credits per semester: 4
Max credits per degree: 4
Format: IND

PHYS 401 Computational Physics
Crosslisted with: PHYS 801
Prerequisites: PHYS 311 or parallel.
Description: Re-formulation of physics problems for solution on a computer, control of errors in numerical work, and programming.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

PHYS 422 Introduction to Physics and Chemistry of Solids
Crosslisted with: PHYS 822, ECEN 422, ECEN 822
Prerequisites: PHYS 213 or CHEM 481/881, MATH 221/821, or permission.
Description: Introduction to structural, thermal, electrical, and magnetic properties of solids, based on concepts of atomic structure, chemical bonding in molecules, and electron states in solids. Principles underlying molecular design of materials and solid-state devices.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

PHYS 431 Thermal Physics
Crosslisted with: PHYS 831
Prerequisites: PHYS 213
Description: Thermal phenomena from the point of view of thermodynamics, kinetic theory, and statistical mechanics.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

ACE: ACE 10 Integrated Product

PHYS 441 Experimental Physics I
Crosslisted with: PHYS 841
Prerequisites: PHYS 213, 223, and 231; or permission
Notes: Lab fee required.
Description: Methods and techniques of modern experimental physics.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

ACE: ACE 10 Integrated Product

PHYS 442 Experimental Physics II
Crosslisted with: PHYS 842
Prerequisites: PHYS 441/841 or permission
Description: Continuation of PHYS 441/841.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

ACE: ACE 10 Integrated Product
PHYS 443 Experimental Physics III
Crosslisted with: PHYS 843
Prerequisites: PHYS 442/842 or permission.
Description: Continuation of PHYS 442/842.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

PHYS 451 Electromagnetic Theory
Crosslisted with: PHYS 851
Prerequisites: PHYS 213; MATH 221/821.
Description: Theory of electric and magnetic fields and their interaction with charges and currents, Maxwell's equations, electric and magnetic properties of matter.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

PHYS 452 Optics and Electromagnetic Waves
Crosslisted with: PHYS 852
Prerequisites: PHYS 451/851
Description: Production of electromagnetic waves, wave guides and cavities, properties of waves, plane waves, reflection and refraction, interference and coherence phenomena, polarization. Optical properties of matter.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

PHYS 461 Quantum Mechanics
Crosslisted with: PHYS 861
Prerequisites: PHYS 213 and 311; or permission.
Description: Basic concepts and formalism of quantum mechanics with applications to simple systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

PHYS 462 Atoms, Nuclei, and Elementary Particles
Crosslisted with: PHYS 862
Prerequisites: PHYS 461 or permission
Description: Basic concepts and experimental foundation for an understanding of the physics of atoms, nuclei, and elementary particles.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

PHYS 480 Introduction to Lasers and Laser Applications
Crosslisted with: ECEN 480, ECEN 880, PHYS 880
Prerequisites: PHYS 213/(UNO) PHYS 2130.
Description: Physics of electronic transition production stimulated emission of radiation. Threshold conditions for laser oscillation. Types of lasers and their applications in engineering.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

PHYS 491 Special Topics in Physics
Crosslisted with: PHYS 891
Prerequisites: PHYS 213 and permission.
Description: Topics vary.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 9
Format: LEC

PLEASE NOTE
This document represents a sample 4-year plan for degree completion with this major. Actual course selection and sequence may vary and should be discussed individually with your college or department academic advisor. Advisors also can help you plan other experiences to enrich your undergraduate education such as internships, education abroad, undergraduate research, learning communities, and service learning and community-based learning.

Physics (B.A.)

16 HR TERM 1

Physics Core
complete PHYS 201

1hr

Physics Core
complete 2 from PHYS 211, PHYS 221, PHYS 141

5hr

Complete PHYS 211 and 221 or PHYS 141. PHYS 211 also fulfills the ACE 4 requirement.

Calculus I
complete MATH 106

5hr

MATH 106 becomes critical to your success in the major if not completed by the second term of enrollment. MATH 106 also fulfills the ACE 3 requirement.

CDR E: Language
recommend 1 or more courses

5hr

If not complete, choose a language course according to your placement and proficiency. CDR E is met after 4th level (202) of most languages.

14 HR TERM 2
**Mathematics**

complete MATH 107

4hr

Math 107 fulfills the CDR F requirement.

**Physics Core**

complete 2 from PHYS 212, PHYS 222, PHYS 142

5hr

Complete PHYS 212 and 222 or PHYS 142. PHYS 212 becomes critical to your success in the major if not completed by the fourth term of enrollment. PHYS 212 also fulfills the CDR B requirement.

**CDR E: Language**

recommend 1 or more courses

If not complete, choose a language course according to your placement and proficiency. CDR E is met after 4th level (202) of most languages.

**15 HR TERM 3**

**Mathematics**

complete MATH 208

4hr

**Physics Core**

complete PHYS 213, PHYS 223

5hr

**ACE 1 Written Texts**

complete 1 from ACE1

3hr

**CDR E: Language**

recommend 1 or more courses

If not complete, choose a language course according to your placement and proficiency. CDR E is met after 4th level (202) of most languages.

**16 HR TERM 5**

**Physics Core**

complete PHYS 441

5hr

**ACE 1 Written Texts**

complete 1 from ACE1

3hr

**Phys 441 also fulfills the ACE 10 requirement.**

**Physics Core**

complete PHYS 311

3hr

**CDR E: Language**

recommend 1 or more courses

PHYS 311 becomes critical to your success in the major if not completed by the fifth term of enrollment.

**Additional Physics**

complete 1 from PHYS 343, PHYS 391, PHYS 431, PHYS 451, PHYS 461, PHYS 480

3hr
Physics

3hr complete PHYS 361

Additional Physics

complete 1 from PHYS 343, PHYS 391, PHYS 431, PHYS 451, PHYS 461, PHYS 480

ACE 5 Humanities

complete 1 from ACE5

ACE 6 Social Sciences

complete 1 from ACE6

Electives

complete Any Course

In consultation with your advisor, select elective courses or courses that meet a 2nd major, minor, sci-base or upper level requirement.

15 HR TERM 6

Physics Core

complete PHYS 361

ACE 8 Ethical Principles

complete 1 from ACE8

ACE 9 Global/Human Divers

complete 1 from ACE9

CDR C: Humanities

complete 1 from Any Arabic Course at the 300 Level, Any Classics Course, Any Czech Course at the 300 Level, Any English Course, FREN 282, Any French Course at the 300 Level, Any Greek Course at the 300 Level, Any Hebrew Course at the 300 Level, Any History Course, Any Japanese Course at the 300 Level, Any Latin Course at the 300 Level, Any Russian Course at the 300 Level, SPAN 264, SPAN 265, Any Spanish Course at the 300 Level, Any Spanish Course at the 400 Level

Electives

complete Any Course

In consultation with your advisor, select elective courses or courses that meet a 2nd major, minor, sci-base or upper level requirement.

15 HR TERM 7

Additional Related Course

complete 1 from Any Astronomy Course at the 300 Level, Any Astronomy Course at the 400 Level, Any Biochemistry Course at the 300 Level, Any Biochemistry Course at the 400 Level, Any Biological Science Course at the 300 Level, Any Biological Science Course at the 400 Level, Any Biosystems Engineering Course at the 300 Level, Any Biosystems Engineering Course at the 400 Level, Any Chemistry Course at the 300 Level, Any Chemistry Course at the 400 Level, Any Chemical Engineering Course at the 300 Level, Any Chemical Engineering Course at the 400 Level, Any Civil Engineering Course at the 300 Level, Any Civil Engineering Course at the 400 Level, Any Geology Course at the 300 Level, Any Geology Course at the 400 Level, Any Math Course at the 300 Level, Any Math Course at the 400 Level, Any Mechanical Engineering Course at the 300 Level, Any Mechanical Engineering Course at the 400 Level, Any Meteorology Course at the 300 Level, Any Meteorology Course at the 400 Level, Any Mechanized Systems Management Course at the 300 Level, Any Mechanized Systems Management Course at the 400 Level, Any Physics Course at the 300 Level, Any Physics Course at the 400 Level, Any Statistics Course at the 300 Level, Any Statistics Course at the 400 Level.

Complete an approved course in Math, Statistics, or Science at the 300 or 400 level.

ACE 8 Ethical Principles

complete 1 from ACE8

ACE 9 Global/Human Divers

complete 1 from ACE9

CDR C: Humanities

complete 1 from Any Arabic Course at the 300 Level, Any Classics Course, Any Czech Course at the 300 Level, Any Czech Course at the 400 Level, Any English Course, FREN 282, Any French Course at the 300 Level, Any French Course at the 400 Level, GERM 282, Any German Course at the 300 Level, Any German Course at the 400 Level, Any Greek Course at the 300 Level, Any Greek Course at the 400 Level, Any Hebrew Course at the 300 Level, Any Hebrew Course at the 400 Level, Any History Course, Any Japanese Course at the 300 Level, Any Latin Course at the 300 Level, Any Latin Course at the 400 Level, Any Philosophy Course, Any Religious Studies Course at any Level, Any Russian Course at the 300 Level, Any Russian Course at the 400 Level, SPAN 264, SPAN 265, Any Spanish Course at the 300 Level, Any Spanish Course at the 400 Level

Complete an approved course from a Humanities discipline: ARAB, CLAS, CZEC, ENGL, FILM, FREN, GERM, GREK, HEBR, HIST, JAPN, LATN, PHIL, RELG, RUSS, SPAN.
In consultation with your advisor, select elective courses or courses that meet a 2nd major, minor, sci-base or upper level requirement.

**14 HR TERM 8**

**Additional Related Course**

Complete 1 from Any Astronomy Course at the 300 Level, Any Astronomy Course at the 400 Level, Any Biochemistry Course at the 300 Level, Any Biochemistry Course at the 400 Level, Any Biological Science Course at the 300 Level, Any Biological Science Course at the 400 Level, Any Biosystems Engineering Course at the 300 Level, Any Biosystems Engineering Course at the 400 Level, Any Chemistry Course at the 300 Level, Any Chemistry Course at the 400 Level, Any Chemical Engineering Course at the 300 Level, Any Chemical Engineering Course at the 400 Level, Any Civil Engineering Course at the 300 Level, Any Civil Engineering Course at the 400 Level, Any Geology Course at the 300 Level, Any Geology Course at the 400 Level, Any Math Course at the 300 Level, Any Math Course at the 400 Level, Any Mechanical Engineering Course at the 300 Level, Any Mechanical Engineering Course at the 400 Level, Any Meteorology Course at the 300 Level, Any Meteorology Course at the 400 Level, Any Mechanized Systems Management Course at the 300 Level, Any Mechanized Systems Management Course at the 400 Level, Any Physics Course at the 300 Level, Any Physics Course at the 400 Level, Any Statistics Course at the 300 Level, Any Statistics Course at the 400 Level

3hr

Complete an approved course in Math, Statistics, or Science at the 300 or 400 level.

**ACE 7 Arts**

Complete 1 from ACE7

3hr

**CDR D: Social Sciences**

Complete 1 from Any Anthropology Course, Any Communications Course, Any Geography Course, Any National Securities Studies Course, Any Political Science Course, Any Psychology Course, Any Sociology Course

3hr

Complete an approved course from a Social Science discipline: ANTH, COMM, GEOG, NSST, POLS, PSYC, SOCI.

**Electives**

Complete Any Course

5hr

In consultation with your advisor, select elective courses or courses that meet a 2nd major, minor, sci-base or upper level requirement.

**Graduation Requirements**

1. A minimum 2.00 GPA required for graduation.
2. **Total Credits Applying Toward 120 Total Hours***

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**Physics (B.S.)**

**14 HR TERM 1**

**Physics Core**

Complete PHYS 201, PHYS 211, PHYS 221

6hr

C

PHYS 211 also fulfills the ACE 4. PHYS 221 fulfills the CDR BL requirement.

**Calculus I**

Complete MATH 106

5hr

C

Becomes critical to your success in the major if not completed by the second term of enrollment. MATH 106 also fulfills the ACE 3 requirement.

**CDR E: Language**

Recommend 1 or more courses

3hr

If not complete, choose a language course according to your placement and proficiency. CDR E is met after 4th level (202) of most languages.

**15 HR TERM 2**

**Calculus II**

Complete MATH 107

4hr

C

MATH 107 fulfills the CDR F requirement.

**Physics Core**

Complete PHYS 212, PHYS 222

5hr

C

PHYS 212 becomes critical to your success in the major if not completed by the fourth term of enrollment. PHYS 212 also fulfills the CDR B requirement.

**ACE 1 Written Texts**
CDR E: Language
recommend 1 or more courses

If not complete, choose a language course according to your placement and proficiency. CDR E is met after 4th level (202) of most languages.

16 HR TERM 3

Calculus III
complete MATH 208

Physics Core
complete PHYS 213, PHYS 223

Chemistry
complete CHEM 113

CDR A: Writing
complete 1 from ACE1

Complete an additional course approved as ACE 1.

15 HR TERM 4

Mathematics
complete MATH 221

Physics Core
complete PHYS 231

ACE 2 Communication Skill
complete 1 from ACE2

ACE 5 Humanities
complete 1 from ACE5

Electives
complete Any Course

In consultation with your advisor, select elective courses or courses that meet a 2nd major, minor, sci-base or upper level requirement.

15 HR TERM 5

Physics Core
complete PHYS 431

Physics Core
complete PHYS 311

PHYS 311 becomes critical to your success in the major if not completed by the fifth term of enrollment.

Professional Opt Course
complete PHYS 441

PHYS 441 also fulfills the ACE 10 requirement. Other Options include Optics and Lasers, Materials, and Computational.

CDR C: Humanities
complete 1 from Any Arabic Course at the 300 Level, Any Classics Course, Any Czech Course at the 300 Level, Any Czech Course at the 400 Level, Any English Course, FREN 282, Any French Course at the 300 Level, Any French Course at the 400 Level, GERM 282, Any German Course at the 300 Level, Any German Course at the 400 Level, Any Greek Course at the 300 Level, Any Greek Course at the 400 Level, Any Hebrew Course at the 300 Level, Any History Course, Any Japanese Course at the 300 Level, Any Latin Course at the 300 Level, Any Latin Course at the 400 Level,
Any Philosophy Course, Any Religious Studies Course at any Level, Any Russian Course at the 300 Level, Any Russian Course at the 400 Level, SPAN 264, SPAN 265, Any Spanish Course at the 300 Level, Any Spanish Course at the 400 Level.

Complete an approved course from a Humanities discipline: ARAB, CLAS, CZEC, ENGL, FILM, FREN, GERM, GREK, HEBR, HIST, JAPN, LATN, PHIL, RELG, RUSS, SPAN.

**ACE 6 Social Sciences**

complete 1 from ACE6

**15 HR TERM 6**

**Physics Core**

complete PHYS 451, PHYS 461

**ACE 8 Ethical Principles**

complete 1 from ACE8

**Professional Opt Course**

complete PHYS 442

Other Options include Optics and Lasers, Materials, and Computational.

**Electives**

complete Any Course

In consultation with your advisor, select elective courses or courses that meet a 2nd major, minor, sci-base or upper level requirement.

**15 HR TERM 7**

**Professional Opt Course**

complete PHYS 452

Other Options include Optics and Lasers, Materials, and Computational.

**ACE 7 Arts**

**Professional Opt Course**

complete 1 from ASTR 403, ASTR 404, ASTR 405, ASTR 407, PHYS 343, PHYS 361, PHYS 391, PHYS 401, PHYS 422, PHYS 443, PHYS 480, MATH 314, MATH 424

Complete an approved course from a Social Science discipline: ANTH, COMM, GEOG, NSST, POLS, PSYC, SOCI.

**Electives**

complete Any Course

In consultation with your advisor, select elective courses or courses that meet a 2nd major, minor, sci-base or upper level requirement.

**15 HR TERM 8**

**Professional Opt Course**

complete PHYS 462

Other Options include Optics and Lasers, Materials, and Computational.

**Professional Opt Course**

complete 1 from MATH 314, PHYS 401, ASTR 404, PHYS 361, ASTR 403, ASTR 404, ASTR 405, ASTR 407, PHYS 343, PHYS 361, PHYS 391, PHYS 401, PHYS 422, PHYS 443, PHYS 480, MATH 314, MATH 424

Other Options include Optics and Lasers, Materials, and Computational.
complete 1 from ACE7

**Electives**

complete Any Course

In consultation with your advisor, select elective courses or courses that meet a 2nd major, minor, sci-base or upper level requirement.

**Graduation Requirements**

1. A minimum 2.00 GPA required for graduation.
2. ***Total Credits Applying Toward 120 Total Hours***
3. Complete 30 hours in residence at UNL.

**Career Information**

*The following represents a sample of the internships, jobs and graduate school programs that current students and recent graduates have reported.*

**Transferable Skills**

- Comprehend and critically evaluate complex information
- Use quantitative & analytical computational techniques
- Make predictions using mathematical, statistical, and scientific modeling methods
- Understand and use proper laboratory and technical skills and instruments
- Define problems and identifying causes
- Support and communicate claims using clear evidence
- Simplify complex information and present it to others
- Apply mathematical and scientific skills to solve real-world problems
- Document and replicate processes and procedures
- Design and implement research experiments

**Jobs of Recent Graduates**

- Process Engineer I, Garmin - Olathe KS
- Software Developer, Applied Underwriters - Omaha NE
- Teaching Assistant, University of Nebraska-Lincoln - Lincoln NE
- Research assistant, University of Nebraska-Lincoln - Lincoln NE
- Systems Programmer, Bryan Health - Lincoln NE
- Loan Advisor, Nelnet - Omaha NE
- Science Teacher, Lincoln Public Schools - Lincoln NE
- Software Developer Engineer, CSG International - Omaha NE
- Science teacher 9-12, Millard Public Schools - Omaha NE

**Internships**

- Recording Head Reader Process Intern, Eng. Intern, Seagate Technology - Bloomington MN
- Intern, UNL Holland Computing - Lincoln NE

**Grad Schools**

- Ph.D. Physics, University of Nebraska-Lincoln - Lincoln NE
- Ph.D. in Chemical Physics, University of Maryland-College Park - College Park MD
- PhD in Atomic/Molecular/Optical Physics, University of Nebraska-Lincoln - Lincoln NE
- Medical Degree, University of Nebraska Medical Center - Omaha NE
- Masters-Engineering, University of Nebraska-Lincoln - Lincoln NE
- MAT Science Education, Boston University - Boston MA
- Ph.D. in Astronomy, University of California-Berkeley - Berkley CA
- Geophysics, California Institute of Technology - Pasadena CA
- Chemistry PhD, California Technical -
- Ph. D. in Astrophysics, University of Massachusetts Amherst - Amherst MA