PHYSICS

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 languages. Four years of high school language will exempt students from the College of Arts and Sciences’ language requirement. It will also allow students to continue language study at a more advanced level, and give 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 Admissions 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 submit either the ACT or SAT scores.

Ordinarily, hours earned at an accredited college are accepted by the University. The College, however, will evaluate all hours submitted on an application for transfer and reserves the right to accept or reject any of them. Sixty is the maximum number of hours the University will accept on transfer 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
Students readmitted to the College of Arts and Sciences will follow the requirements stated in the bulletin for the academic year of readmission and reenrollment as a degree-seeking student in Arts and Sciences. In consultation with advisors, a student may choose to follow a bulletin 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 bulletin year. Beginning in 1990-1991, the bulletin 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 before graduating from the College of Arts and Sciences and should consult a college advisor in the Academic and Career Advising Center in 107 Oldfather Hall for questions about admission deficiencies.

Removing Foreign Language Deficiencies
Students must complete the second semester of the 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 two high school geometry courses by Independent Study or by completing a geometry course from an accredited community college or a four-year institution. Neither of these options count for college credit.

College Degree Requirements

College General Education Requirements
The College of Arts and Sciences distribution requirements are designed to further the purposes of liberal education by encouraging study in several different areas. Courses satisfying these requirements may impart specialized knowledge or broadly connect the subject matter to other areas of knowledge.

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 major to satisfy the Breadth Requirement (F), but may apply an ancillary requirement of the primary major or a course from their second 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).

Bachelor of Arts or Bachelor of Science (16 credits + Language)
A. Written Communication: 3 hours
  To be selected from courses approved for ACE outcome 1.
B. Natural, Physical and Mathematical Sciences: 4 hours
  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. Select courses from geography and anthropology may also be used to satisfy the lab requirement.

C. Humanities: 3 hours
Select from: classics, English, history, modern languages and literatures, philosophy, and religious studies.

D. Social Sciences: 3 hours
Select from: anthropology, communication studies, geography, political science, psychology, or sociology.

E. Languages Classical and Modern: 0-6 hours
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 languages requirement.

F. Additional Breadth Requirement (may not be used toward the primary major; may apply toward ancillary requirements and second majors): 3 hours
Select from: natural, physical and mathematical sciences (Area B), humanities (Area C), or social sciences (Area D).

1 See your 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
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 BIOC 101 Career Opportunities in Biochemistry), biological sciences (excluding CASC 160 Introduction to Dentistry and Dental Hygiene, BIOS 160 Introduction to Clinical Laboratory Science, BIOS 203 Bioethics), chemistry (excluding CHEM 101 Career Opportunities in Chemistry), computer science (excluding CSCE 10 Introduction to CSE), geography (selected courses), geology, life sciences, mathematics (excluding courses below MATH 104 Applied Calculus), meteorology, 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
1. For the University entrance requirements, students must show an official high school transcript with two or more years of the same foreign language in high school.
2. 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.
3. For the College of Arts and Sciences College Distribution Requirement E-Language, 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
1. 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:

<table>
<thead>
<tr>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arabic</td>
</tr>
<tr>
<td>French</td>
</tr>
<tr>
<td>German</td>
</tr>
<tr>
<td>Spanish</td>
</tr>
<tr>
<td>Russian</td>
</tr>
<tr>
<td>Czech</td>
</tr>
<tr>
<td>Japanese</td>
</tr>
<tr>
<td>Chinese</td>
</tr>
</tbody>
</table>

The Department of Modern Languages will oversee the test and provide written documentation to the Arts and Sciences Advising Center that the student has passed the proficiency test at the 102 level.

2. 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.

Distance Education
1. 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.

2. 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 Requirements E-Languages requirement. If this waiver were granted, the student would then be required to complete 101 and 102 in another (3rd 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.

For students in Arts and Sciences, the University regulations for Pass/No Pass apply as follows:

- 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 (1/2 of the course).
- 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 Pass/No Pass.
- 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.
- Many Arts and Sciences departments and programs do not allow courses in the major or minor to be taken Pass/No Pass; students should refer to the department’s or program’s section of the bulletin 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.

Students who wish to apply P/N hours to their major and minor(s) must obtain approval on a form that is available in the Arts and Sciences Advising Center, 107 Oldfather Hall.

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. NOTE: ALEC 397E and ALEC 397K do not count toward these 30 hours.

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 course work 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 10 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 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.

Bulletin Rule

Students must fulfill the requirements stated in the bulletin 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 bulletin 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 bulletin year. Beginning in 1990-1991 the bulletin 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>
<tr>
<td>MATH 208</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 213</td>
<td>General Physics III</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 223</td>
<td>General Physics Laboratory III</td>
<td>1</td>
</tr>
<tr>
<td>MATH 221</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 231</td>
<td>Electrical and Electronic Circuits</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 311</td>
<td>Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 431</td>
<td>Thermal Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 451</td>
<td>Electromagnetic Theory</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 461</td>
<td>Quantum Mechanics</td>
<td>3</td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 51

Total Credit Hours: 51

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>
<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></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 Solids</td>
<td>6</td>
</tr>
<tr>
<td>ECEN 422</td>
<td></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 Applications</td>
<td>6</td>
</tr>
<tr>
<td>ECEN 480</td>
<td></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 Equations</td>
<td>18</td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 18

Total Credit Hours: 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 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>
<tr>
<td>PHYS 480</td>
<td>Introduction to Lasers and Laser Applications</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 480</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Select at least 6 hours of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 391</td>
<td>Undergraduate Research</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 361</td>
<td>Concepts of Modern Physics</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 401</td>
<td>Computational Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 422</td>
<td>Introduction to Physics and Chemistry of Solids</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 422</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHYS 442</td>
<td>Experimental Physics II</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 462</td>
<td>Atoms, Nuclei, and Elementary Particles</td>
<td>3</td>
</tr>
<tr>
<td>MATH 314</td>
<td>Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>or MATH 424</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 18
Total Credit Hours 18

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.

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>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 114</td>
<td>Fundamental Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 221</td>
<td>Elementary Quantitative Analysis</td>
<td>4</td>
</tr>
<tr>
<td>MATL 360</td>
<td>Elements of Materials Science</td>
<td>4</td>
</tr>
<tr>
<td>MATL 462</td>
<td>X-ray Diffraction</td>
<td>3</td>
</tr>
<tr>
<td>or MATL 471</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHYS 422</td>
<td>Introduction to Physics and Chemistry of Solids</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 422</td>
<td></td>
<td></td>
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</tbody>
</table>

Select at least 3 hours of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 391</td>
<td>Undergraduate Research</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 261</td>
<td>Organic Chemistry</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 481</td>
<td>Physical Chemistry I</td>
<td>1</td>
</tr>
<tr>
<td>ECEN 216</td>
<td>Electronics and Circuits II</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 343</td>
<td>Physics of Lasers and Modern Optics</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 401</td>
<td>Computational Physics</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 441</td>
<td>Experimental Physics I</td>
<td>1</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>
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<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>Select one of the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHYS 211</td>
<td>General Physics I</td>
<td>1</td>
</tr>
<tr>
<td>&amp; PHYS 221</td>
<td>General Physics Laboratory I (preferred)</td>
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<td>or PHYS 141</td>
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<tr>
<td>MATH 107</td>
<td>Calculus II</td>
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<tr>
<td>CHEM 113</td>
<td>Fundamental Chemistry I (preferred)</td>
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<td>or CHEM 111</td>
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<tr>
<td>or CHEM 10</td>
<td>General Chemistry I</td>
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<tr>
<td>MATH 208</td>
<td>Calculus III</td>
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<td>Select one of the following:</td>
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<tr>
<td>PHYS 212</td>
<td>General Physics II</td>
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</tr>
<tr>
<td>&amp; PHYS 222</td>
<td>General Physics Laboratory II (preferred)</td>
<td></td>
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<tr>
<td>or PHYS 142</td>
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</table>

Credit Hours Subtotal: 20
Total Credit Hours 20
## Plan B Minor (15 hours)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>PHYS 201</td>
<td>Modern Topics in Physics and Astronomy</td>
<td>1</td>
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<td>Select one of the following options:</td>
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<tr>
<td>PHYS 211 &amp; PHYS 221 &amp; PHYS 212 &amp; PHYS 222 or PHYS 141 &amp; PHYS 142</td>
<td>General Physics I and General Physics Laboratory I and General Physics II and General Physics Laboratory II or General Physics I and General Physics Laboratory II</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 213</td>
<td>General Physics III</td>
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</tbody>
</table>

**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 203

**ACE**: ACE 4 Science

## ASTR 103H Honors: Descriptive Astronomy

**Prerequisites**: Good standing in the University Honors Program or by invitation

**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". Broad look at astronomy for non-science majors.

**Credit Hours**: 3

**Max credits per semester**: 3

**Max credits per degree**: 3

**Format**: LEC

**Prerequisite for**: 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  
**Description:** Exploration of equipment and techniques needed to observe and investigate the motions and objects in the night sky. The course consists of 2 lecture hours and three evening laboratory hours per week.  
**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  
**Description:** Survey of the sun, the solar system, stellar properties, stellar systems, interstellar matter, galaxies, and cosmology. ASTR 204 is an introductory course designed for science majors.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC

ASTR 224 Astronomy and Astrophysics Laboratory  
**Prerequisites:** Must be currently enrolled in or have already completed 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 403H, 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  
**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 407H, 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 407H Physics of the Interstellar Medium  
**Crosslisted with:** ASTR 407, 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
Crosslisted with: PHYS 115H
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 115H Descriptive Physics
Crosslisted with: PHYS 115
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
Description: Mechanics, heat, waves and sound. Credit toward the degree may be earned in only one of: PHYS 141, 141H, and 151.
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
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 452, MSYM 852, WATS 452, AGRO 452
ACE: ACE 4 Science

PHYS 142 Elementary General Physics II
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
ACE: ACE 4 Science

PHYS 142H Honors: Elementary General Physics II
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
ACE: ACE 4 Science

PHYS 151 Elements of Physics
Crosslisted with: PHYS 151H
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 toward the degree may be earned in only one of: PHYS 141, 141H, and 151.
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 151H Elements of Physics
Crosslisted with: PHYS 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 toward the degree may be earned in only one of: PHYS 141, 141H, and 151.
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
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  
**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:** ASTR 204; BSEN 317, BSEN 317H; MECH 223; MECH 250; METR 312; METR 323; MSYM 232; MSYM 262  
**ACE:** ACE 4 Science

PHYS 211H Honors: General Physics I  
**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:** ASTR 204; BSEN 317, BSEN 317H; MECH 223; MECH 250; METR 312; METR 323; MSYM 232; MSYM 262  
**ACE:** ACE 4 Science

PHYS 212 General Physics II  
**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, AGEN 325H, BSEN 325, BSEN 325H; ECEN 306; GEOL 344; MATL 360, MATL 360H; MECH 421, MECH 821, ENGR 421  
**ACE:** ACE 4 Science

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

PHYS 213 General Physics III  
**Prerequisites:** PHYS 212; MATH 208 or parallel  
**Description:** Continuation of PHYS 212. Relativity, quantum mechanics, atoms, and nuclei.  
**Credit Hours:** 4  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC  
**Prerequisite for:** ECEN 421

PHYS 213H Honors: General Physics III  
**Description:** Continuation of PHYS 212H. Relativity, quantum mechanics, atoms, and nuclei.  
**Credit Hours:** 4  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC  
**Prerequisite for:** ECEN 421

PHYS 221 General Physics Laboratory I  
**Description:** Experiments in mechanics, heat and wave motion.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Format:** LAB

PHYS 222 General Physics Laboratory II  
**Description:** Laboratory experiments in electromagnetism and optics.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Format:** LAB

PHYS 223 General Physics Laboratory III  
**Description:** Experiments in atomic and nuclear physics.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Format:** LAB

PHYS 231 Electrical and Electronic Circuits  
**Crosslisted with:** PHYS 231H  
**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

PHYS 231H Electrical and Electronic Circuits  
**Crosslisted with:** PHYS 231  
**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
PHYS 260 Liberal Arts Physics: Matter and Motion
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
ACE: ACE 4 Science

PHYS 261 Liberal Arts Physics: Atoms and Fields
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
ACE: ACE 4 Science

PHYS 262 Physical Sciences by Inquiry
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
Credit Hours: 1-12
Min credits per semester: 1
Max credits per semester: 12
Max credits per degree: 12
Format: LEC

PHYS 311 Mechanics
Crosslisted with: PHYS 311H
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 311H Mechanics
Crosslisted with: PHYS 311
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
Crosslisted with: PHYS 343H
Prerequisites: PHYS 142 or 212; and a lab course in science or engineering
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 343H Physics of Lasers and Modern Optics
Crosslisted with: PHYS 343
Prerequisites: PHYS 142 or 212; and a lab course in science or engineering
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
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

PHYS 391 Undergraduate Research
Description: Research participation.
Credit Hours: 1-4
Min credits per semester: 1
Max credits per semester: 4
Max credits per degree: 8
Format: IND

PHYS 399H Honors Course
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
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 422H, PHYS 822  
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 422H Introduction to Physics and Chemistry of Solids  
Crosslisted with: PHYS 422, PHYS 822  
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 431H, 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

PHYS 431H Thermal Physics  
Crosslisted with: PHYS 431, PHYS 831  
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

PHYS 441 Experimental Physics I  
Crosslisted with: PHYS 841  
Prerequisites: PHYS 213, 223, and 231; or permission  
Description: Methods and techniques of modern experimental physics. Lab fee required.  
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 442H, 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 442H Experimental Physics II  
Crosslisted with: PHYS 442, 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

PHYS 443 Experimental Physics III  
Crosslisted with: PHYS 843  
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: 1-3  
Min credits per semester: 1  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC  
ACE: ACE 10 Integrated Product

PHYS 451 Electromagnetic Theory  
Crosslisted with: PHYS 451H, PHYS 851  
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 451H Electromagnetic Theory  
Crosslisted with: PHYS 451, PHYS 851  
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 452H, 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 452H Optics and Electromagnetic Waves  
Crosslisted with: PHYS 452, 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 461H, PHYS 861
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 461H Quantum Mechanics
Crosslisted with: PHYS 461, PHYS 861
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: PHYS 880
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
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.

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
• More...
  • 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
• More...
  • 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
• More...
  • 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 Technichal -
  • Ph. D. in Astrophysics, University of Massachusetts Amherst - Amherst MA