

# PHYSICS

## Description

Physics, as a foundational scientific discipline, endeavors to comprehend the workings of the universe through the use of a small set of fundamental principles. Students with a background in physics are prepared for a wide variety of careers in science and engineering fields. Members of the Department of Physics and Astronomy conduct research in Atomic, Molecular, Optical, and Plasma Physics; Condensed Matter and Material Physics; and High Energy Physics. This research informs classroom teaching and also provides unique experiential learning opportunities for students.

The Bachelor of Science (BS) program is designed to equip students for careers spanning industry, teaching, graduate studies, and professional schools. The Bachelor of Arts (BA) program provides a more diverse curriculum encompassing science and liberal arts, catering to diverse pre-professional paths and fostering interdisciplinary studies, including biophysics, chemical physics, and geophysics.

## Learning Outcomes

Graduates with a major in physics will:

1. Demonstrate a conceptual understanding of the fundamental principles and concepts of physics, including those in the areas of mechanics, electromagnetism, thermodynamics, and quantum mechanics.
2. Apply mathematical tools to analyze and solve problems.
3. Critically evaluate and interpret data.
4. Communicate concepts and approaches effectively, both orally and in writing.

## Academic and Career Advising

### Academic and Career Advising Center

Not sure where to go or who to ask? The Advising Center team in 107 Oldfather Hall can help. The Academic and Career Advising Center is the undergraduate hub for CAS students in all majors. Centrally located and easily accessed, students encounter friendly, knowledgeable people who are eager to help or connect students to partner resources. Students also visit the Advising Center in 107 Oldfather Hall to:

- Choose or change their major, minor, or degree program.
- Check on policies, procedures, and deadlines.
- Get a college approval signature from the Dean's representatives.

CAS Career Coaches are available by appointment (in-person or Zoom) and located in the CAS Academic and Career Advising Center, 107 Oldfather Hall. They help students explore majors and minors, gain experience, and develop a plan for life after graduation.

### Assigned Academic Advisors

Academic advisors are critical resources dedicated to students' academic, personal, and professional success. Every CAS student is assigned an academic advisor based on their primary major. Since most CAS students have more than just a single major, it is important to get to know the advisor for any minors or additional majors. Academic advisors work closely with the faculty to provide the best overall support and the discipline specific expertise. They are available for appointments (in-

person or Zoom) and through weekly virtual drop-ins. Assigned advisors are listed in MyRED (<https://its.unl.edu/myunl/>) and their offices may be located in or near the department of the major for which they advise.

Students who have declared a pre-health or pre-law area of interest will also work with advisors in the Exploratory and Pre-Professional Advising Center (Explore Center) in 127 Love South, who are specially trained to guide students preparing to enter a professional school.

For complete and current information on advisors for majors, minors, or pre-professional areas, visit <https://cas.unl.edu/major-advisors> (<https://cas.unl.edu/major-advisors/>), or connect with the Arts and Sciences Academic and Career Advising Center, 107 Oldfather Hall, 402-472-4190, [casadvising@unl.edu](mailto:casadvising@unl.edu).

## Career Coaching

The College believes that **Academics + Experience = Opportunities** and encourages students to complement their academic preparation with real-world experience, including internships, research, education abroad, service, and leadership. Arts and sciences students have access to a powerful network of faculty, staff, and advisors dedicated to providing information and support for their goals of meaningful employment or advanced education. Arts and sciences graduates have unlimited career possibilities and carry with them important career competencies—communication, critical thinking, creativity, context, and collaboration. They have the skills and adaptability that employers universally value. Graduates are prepared to effectively contribute professionally and personally with a solid foundation to excel in an increasingly global, technological, and interdisciplinary world.

Students should contact the career coaches in the Arts and Sciences Academic and Career Advising Center in 107 Oldfather Hall, or their assigned advisor, for more information. The CAS career coaches help students explore career options, identify ways to build experience and prepare to apply for internships, jobs, or graduate school, including help with resumes, applications, and interviewing.

## ACE Requirements

Students must complete one course for each of the ACE Student Learning Outcomes below. Certified course choices are published in the degree audit, or visit the ACE (<http://ace.unl.edu>) website (<http://ace.unl.edu>) for the most current list of certified courses.

### ACE Student Learning Outcomes

ACE 1: Write texts, in various forms, with an identified purpose, that respond to specific audience needs, integrate research or existing knowledge, and use applicable documentation and appropriate conventions of format and structure.

ACE 2: Demonstrate competence in communication skills.

ACE 3: Use mathematical, computational, statistical, logical, or other formal reasoning to solve problems, draw inferences, justify conclusions, and determine reasonableness.

ACE 4: Use scientific methods and knowledge to pose questions, frame hypotheses, interpret data, and evaluate whether conclusions about the natural and physical world are reasonable.

ACE 5: Use knowledge, historical perspectives, analysis, interpretation, critical evaluation, and the standards of evidence appropriate to the humanities to address problems and issues.

ACE 6: Use knowledge, theories, and research perspectives such as statistical methods or observational accounts appropriate to the social sciences to understand and evaluate social systems or human behaviors.

ACE 7: Use knowledge, theories, or methods appropriate to the arts to understand their context and significance.

ACE 8: Use knowledge, theories, and analysis to explain ethical principles and their importance in society.

ACE 9: Exhibit global awareness or knowledge of human diversity through analysis of an issue.

ACE 10: Generate a creative or scholarly product that requires broad knowledge, appropriate technical proficiency, information collection, synthesis, interpretation, presentation, and reflection.

## College Degree Requirements

### College Distribution Requirements – BA and BS

The College of Arts and Sciences distribution requirements are common to both the bachelor of arts and bachelor of science degrees and are designed to ensure a range of courses. By engaging in study in several different areas within the College, students develop the ability to learn in a variety of ways and apply their knowledge from a variety of perspectives. All requirements are in addition to University ACE requirements, and no course can be used to fulfill both an ACE outcome and a College Distribution Requirement.

- A student may not use a single course to satisfy more than one College Distribution Requirement, with the exception of CDR Diversity. Courses used to meet CDR Diversity may also meet CDR Writing, CDR Humanities, or CDR Social Science.
- Internship (395 or 495), independent study or readings (396 or 496), research (398 or 498), and thesis (399, 399H, 499, or 499H) will not satisfy distribution requirements.
- Other courses with a 9 in the middle number (ex. PSYC 292) will not satisfy distribution requirements unless approved by an advisor.
- Cross-listed courses from interdisciplinary programs will be applied in the same area as courses from the lead department.

#### College Distribution Requirements

**CDR: Written Communication** 3

Select from courses approved for ACE outcome 1.

**CDR: Natural, Physical, and Mathematical Sciences**<sup>1</sup> 3-4

Select a course from ASTR, BIOS, CHEM, GEOL, LIFE, METR, MATH, PHYS, or ANTH 242, GEOG 155, GEOG 181, POLS 250, or PSYC 273.

**CDR: Laboratory**<sup>2</sup> 0-1

Laboratory courses may be embedded in a 4-5 credit course used in CDR Natural, Physical, and Mathematical Science (example GEOG 155), or stand alone (example LIFE 120L).

**CDR: Humanities**<sup>3</sup> 3

Select a course from ARAB, CHIN, CLAS, CZEC, ENGL, FILM, FREN, GERM, GREK, HIST, JAPN, LATN, PHIL, RELG, RUSS, or SPAN.

**CDR: Social Science**<sup>4</sup> 3

Select a course from ANTH, COMM, GEOG, NSST, POLS, PSYC, or SOCI.

**CDR: Human Diversity in U.S. Communities** 0-3

Select from the following approved courses also listed in your degree audit: ANTH 130, ANTH 412, ANTH 473, ARAB 313, COMM 311, COMM 364, COMM 465, ENGL 212, ENGL 245N, ENGL 312, ENGL 345D, ENGL 345N, ENGL 346, ENGL 376, ENGL 380, ENGL 445, ETHN 100, ETHN 201, ETHN 202, ETHN 205, FILM 344, GEOG 271, GEOG 403, GLST 350, HIST 115, HIST 246, HIST 251, HIST 323, HIST 340, HIST 351, HIST 356, HIST 357, HIST 402, PHIL 105, PHIL 106, PHIL 218, PHIL 323, PHIL 325, POLS 333, POLS 338, POLS 347, PSYC 310, PSYC 330, PSYC 421, PSYC 425, RELG 134, RELG 226, RELG 227, RELG 313, SOCI 101, SOCI 180, SOCI 200, SOCI 217, SPAN 206, SPAN 486, WMNS 101, WMNS 201, WMNS 202, WMNS 210, WMNS 356

**CDR: Language**<sup>5</sup> 0-16

Fulfilled by the completion of the 4th level of a single language (either in H.S. or in college). Language study at UNL is available in: ARAB, CHIN, CZEC, FREN, GERM, GREK, JAPN, LATN, RUSS, SLPA, or SPAN.

**Credit Hours Subtotal:** 12-33

<sup>1</sup> *Excluded courses:* BIOC 101, BIOS 100, CHEM 101, MBIO 101, PHYS 201, MATH 100A, MATH 101, MATH 102, MATH 103.

<sup>2</sup> ANTH 242L, ASTR 224, BIOS 101L, BIOS 110L, BIOS 111, BIOS 116, BIOS 213L, BIOS 214, CHEM 105L, CHEM 106L, CHEM 109L, CHEM 110L, CHEM 113L, GEOG 155, GEOL 101, GEOL 103, LIFE 120L, LIFE 121L, METR 100, PHYS 141, PHYS 142, PHYS 153, PHYS 221, or PHYS 222.

<sup>3</sup> ARAB, CHIN, CZEC, FREN, GERM, GREK, JAPN, LATN, RUSS, and SPAN courses must be numbered 300 or above. ENGL courses must be ENGL 170, ENGL 180, or ENGL 200 level and above. *Excluded courses:* CLAS 116, ENGL 254, ENGL 300, ENGL 354, SPAN 300A, SPAN 303, and SPAN 304.

<sup>4</sup> *Excluded courses:* ANTH 242/ANTH 242L, GEOG 155, GIST 111, GIST 311, POLS 101, POLS 250, PSYC 100, PSYC 273.

<sup>5</sup> ARAB 202, CHIN 202, CZEC 202, FREN 202 or FREN 210, GERM 202, GREK 301 and GREK 302, JAPN 201 and JAPN 202, LATN 301 and LATN 302, RUSS 202, SLPA 202, or SPAN 202 or SPAN 210.

### Language Requirement - BA and BS

The University of Nebraska–Lincoln and the College of Arts and Sciences place great value on academic exposure and proficiency in a second language. The University of Nebraska–Lincoln entrance requirement of two years of the same foreign language or the College's language distribution requirement (CDR: Language) will rarely be waived and only with relevant documentation. See the main College of Arts and Sciences page for more details.

### Experiential Learning Requirement - BA and BS

All undergraduates in the College of Arts and Sciences must complete an Experiential Learning (EL) designated course. This may include 0-credit courses designed to document co-curricular activities recognized as Experiential Learning.

### Scientific Base – BS Only

The bachelor of science degree requires students to complete 60 hours in mathematical, physical, and natural sciences from disciplines within the College of Arts and Sciences or required in its majors: ACTS, ASTR, BIOC,

BIOS, CHEM, CSCE, GEOL, LIFE, METR, MATH, PHYS, STAT or ANTH 242, ANTH 242L, ANTH 341, ANTH 385, ANTH 386, ANTH 389, ANTH 416, ANTH 422, ANTH 430, ANTH 442, ANTH 443, ANTH 444, ANTH 448, ANTH 473, ANTH 484, ANTH 487D, ENVR 201, GEOG 155, GEOG 181, GEOG 217, GEOG 281, GEOG 308, GEOG 317, GEOG 408, GEOG 417, GEOG 418, GEOG 419, GEOG 421, GEOG 422, GEOG 425, GEOG 427, GEOG 432, GEOG 444, GEOG 461, GEOG 467, PHIL 211, POLS 250, PSYC 273, PSYC 368, PSYC 370, PSYC 450, PSYC 451, PSYC 456, PSYC 458, PSYC 460, PSYC 461, PSYC 463, PSYC 464, or PSYC 465.

Excluded courses include: BIOC 101, BIOS 100, CHEM 101, MATH 100A, MATH 101, MATH 102, MATH 103, MBIO 101, PHYS 201 as well as any course numbered 395, 495, 399, 399H, 499, or 499H.

Up to 12 hours of scientific and technical courses offered by other colleges may be accepted toward this requirement with approval of the College of Arts and Sciences. See your assigned academic advisor to start the approval process.

## 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 cumulative 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 domestic institutions except for UNO and UNK. All courses taken at UNO and UNK impact the UNL transcript. No transfer of C- and D grades can be applied toward requirements in a major or a minor. No University of Nebraska–Lincoln C- and D grades can be applied toward requirements in a major or a minor. International coursework (including education abroad) with a final grade equivalent to a C- or lower will not be validated by the College of Arts and Sciences departments to be degree applicable.

### Pass/No Pass Privilege

#### University policy for the Pass/No Pass (P/N) privilege:

- Neither the P nor the N grade factor into your GPA.
- 'P' is interpreted to mean a grade of C or above. A grade of C- or lower results in a 'N'.
- A change to or from a Pass/No Pass may be made until mid-term (1/2 of the course - see the 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 policy governing the grading options.
- Changing to or from the Pass/No Pass grading option requires using MyRED, or processing a Schedule Adjustment Form.
- For undergraduates, the University maximum of 24 'Pass' credit hours and/or college and department limits will apply. These limits do not include courses offered on a 'Pass/No Pass' basis only. Consult your advisor or the Undergraduate Catalog (<https://catalog.unl.edu/undergraduate/>) for restrictions on the number of 'Pass' hours you can apply toward your degree.
- The 'Pass/No Pass' grading option cannot be used for the removal of 'C-', 'D+', 'D', 'D-', or 'F' grade factors.  
*NOTE: See Course Repeats (<https://registrar.unl.edu/academic-standards/course-repeats/>)*

#### College of Arts and Sciences policy on the Pass/No Pass (P/N) privilege:

- Pass hours can count toward fulfillment of University ACE requirements and college distribution requirements up to the 24-hour maximum.
- Most arts and sciences majors and minors do not permit any courses graded Pass/No Pass to apply, or limit them to no more than 6 hours. Students should refer to the major section of the catalog for clarification.
- Departments may specify that certain courses of theirs can be taken on a P/N-only or on a graded-only basis.

## 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 at the 300 or 400 Level

Thirty (30) of the 120 semester hours of credit must be in courses numbered at the 300 or 400 level. Of those 30 hours, 15 hours (1/2) must be completed in residence at the University of Nebraska–Lincoln.

## Residency Requirement

The term "Residency" refers to courses taken at UNL. Students must complete at least 30 of the 120 total hours for their degree at the University of Nebraska–Lincoln. Students must complete at least 18 hours of their major coursework, and 15 of the 30 hours required at the 300 or 400 level, at UNL.

## Catalog to Use

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 the University of Nebraska–Lincoln. 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 the University of Nebraska–Lincoln 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.

**Transfer Students:** Students who have transferred from a community college may be eligible to fulfill the requirements as stated in the catalog for an academic year in which they were enrolled at the community college prior to attending the University of Nebraska-Lincoln. This decision should be made in consultation with academic advisors, provided the student a) was enrolled in a community college during the catalog year they are utilizing, b) maintained continuous enrollment at the previous institution for 1 academic year or more, and c) continued enrollment at the University of Nebraska-Lincoln within 1 calendar year from their last term at the previous institution. Students must complete

all degree requirements from a single catalog year and within the time frame allowable for that catalog year.

## Major Requirements

### Bachelor of Science

Complete the required Physics, Mathematics, and Chemistry core requirements plus elective courses.

#### Core Requirements

##### Physics

PHYS 201	Modern Topics in Physics and Astronomy	1
PHYS 211 & PHYS 221	General Physics I and General Physics Laboratory I	5
PHYS 212 & PHYS 222	General Physics II and General Physics Laboratory II	5
PHYS 213 & PHYS 223	General Physics III and General Physics Laboratory III	5
PHYS 231	Electrical and Electronic Circuits	3
PHYS 311	Mechanics	3
PHYS 431	Thermal Physics	3
PHYS 441	Experimental Physics I	3
PHYS 442	Experimental Physics II	3
PHYS 451	Electromagnetic Theory	3
PHYS 461	Quantum Mechanics	3
Credit Hours Subtotal:		37

##### Mathematics

MATH 106	Calculus I	5
MATH 107	Calculus II	4
MATH 208	Calculus III	4
MATH 221	Differential Equations	3
Credit Hours Subtotal:		16

##### Chemistry

<i>Select one sequence:</i>		4
CHEM 109A & CHEM 109L or CHEM 113 & CHEM 113L	General Chemistry I and General Chemistry I Laboratory Fundamental Chemistry I and Fundamental Chemistry I Laboratory	
Credit Hours Subtotal:		4

**Total Credit Hours** 57

#### Specific Major Requirements

##### Elective Courses

Select at least 12 hours from the following list: <sup>1</sup> 12

ASTR 403	Galactic and Extragalactic Astronomy
ASTR 404	Stellar Astrophysics
ASTR 405	Physics of the Solar System
ASTR 407	Physics of the Interstellar Medium
MATH 314 or MATH 424	Linear Algebra Introduction to Partial Differential Equations
MATL 360 or MATL 462 or MATL 471	Elements of Materials Science X-ray Diffraction Electron Microscopy of Materials
PHYS 343	Physics of Lasers and Modern Optics

PHYS 361	Concepts of Modern Physics	
PHYS 401	Computational Physics	
PHYS 422 / ECEN 422	Introduction to Physics and Chemistry of Solids	
PHYS 443	Experimental Physics III	
PHYS 452	Optics and Electromagnetic Waves	
PHYS 462	Atoms, Nuclei, and Elementary Particles	
PHYS 480 / ECEN 480	Introduction to Lasers and Laser Applications	
Credit Hours Subtotal:		12
<b>Total Credit Hours</b>		<b>12</b>

<sup>1</sup> Up to 3 hours of PHYS 398 may be counted toward these 12 hours by substitution, provided that the research project is approved by the advisor.

### Bachelor of Arts

#### Core Requirements

Complete the required Physics, Mathematics, and Chemistry core requirements plus elective courses.

#### Required Physics Courses

PHYS 201	Modern Topics in Physics and Astronomy	1
<i>Select one sequence:</i>		15
PHYS 141 & PHYS 142 & PHYS 213 & PHYS 223 or PHYS 211 & PHYS 221 & PHYS 212 & PHYS 222 & PHYS 213 & PHYS 223	Physics for Life Sciences I and Physics for Life Sciences II and General Physics III and General Physics Laboratory III General Physics I and General Physics Laboratory I and General Physics II and General Physics Laboratory II and General Physics III and General Physics Laboratory III	
PHYS 231	Electrical and Electronic Circuits	3
PHYS 311	Mechanics	3
PHYS 441	Experimental Physics I	3
Credit Hours Subtotal:		25

##### Mathematics

MATH 106	Calculus I	5
MATH 107	Calculus II	4
MATH 208	Calculus III	4
MATH 221	Differential Equations	3
Credit Hours Subtotal:		16

##### Chemistry

<i>Select one sequence:</i>		4
CHEM 109A & CHEM 109L or CHEM 113 & CHEM 113L	General Chemistry I and General Chemistry I Laboratory Fundamental Chemistry I and Fundamental Chemistry I Laboratory	

Credit Hours Subtotal:	4
<b>Total Credit Hours</b>	<b>45</b>

### Specific Major Requirements

#### Elective Courses

Select at least 9 hours of the following: <sup>1</sup> 9

PHYS 343	Physics of Lasers and Modern Optics
PHYS 361	Concepts of Modern Physics
PHYS 451	Electromagnetic Theory
PHYS 461	Quantum Mechanics
PHYS 431	Thermal Physics
PHYS 480 / ECEN 480	Introduction to Lasers and Laser Applications

Credit Hours Subtotal: 9

**Total Credit Hours** 9

<sup>1</sup> Up to 3 hours of PHYS 398 may be counted toward these 9 hours by substitution, provided that the research project is approved by the advisor.

## 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

Complete 15 hours of Physics courses plus required Mathematics prerequisite courses (MATH 106, MATH 107, MATH 208).

#### Required Physics

PHYS 201	Modern Topics in Physics and Astronomy	1
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Select one sequence from the following: 10

PHYS 211 & PHYS 221 & PHYS 212 & PHYS 222	General Physics I and General Physics Laboratory I and General Physics II and General Physics Laboratory II
PHYS 141 & PHYS 142	Physics for Life Sciences I and Physics for Life Sciences II
PHYS 213	General Physics III

Credit Hours Subtotal: 15

**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

**Grading Option:** Graded with Option

**Prerequisite for:** ASTR 113; ASTR 203

**ACE:** ACE 4 Science

**Course and Laboratory Fee:** \$25

#### 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

**Grading Option:** Graded

**Prerequisite for:** ASTR 113; ASTR 203

**ACE:** ACE 4 Science

**Course and Laboratory Fee:** \$25

#### 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

**Grading Option:** Graded with Option

**ACE:** ACE 4 Science

#### ASTR 117 Life in the Universe

**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

**Grading Option:** Graded with Option

**ACE:** ACE 4 Science



**ASTR 203 Introduction to Observational Astronomy****Prerequisites:** ASTR 103/ASTR 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**Grading Option:** Graded with Option**Course and Laboratory Fee:** \$25**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**Grading Option:** Graded with Option**Prerequisite for:** ASTR 224**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**Grading Option:** Graded with Option**Course and Laboratory Fee:** \$55**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**Grading Option:** Graded with Option**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**Grading Option:** Graded with Option**ASTR 405 Physics of the Solar System****Crosslisted with:** ASTR 805**Prerequisites:** ASTR 204; MATH 107/107H; PHYS 142/142H or PHYS 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**Grading Option:** Graded with Option**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**Grading Option:** Graded with Option**ASTR 492 Special Topics in Astronomy****Crosslisted with:** ASTR 892**Prerequisites:** ASTR 204 and permission.**Description:** Topic varies.**Credit Hours:** 1-6**Min credits per semester:** 1**Max credits per semester:** 6**Max credits per degree:** 6**Grading Option:** Graded with Option**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**Grading Option:** Graded with Option**ACE:** ACE 4 Science

**PHYS 141 Physics for Life Sciences I**

**Prerequisites:** MATH 102, 103, or Math Placement Exam score for MATH 106.

**Notes:** This is the first in a two-course sequence. Credit toward the degree may be earned in only one of: PHYS 141, 141H and 151. Lab fee required.

**Description:** Introduces physics in biological context, investigating the fundamental physics that govern living systems. Topics include mechanics, fluids, heat, and waves, and sound.

**Credit Hours:** 5

**Max credits per semester:** 5

**Max credits per degree:** 5

**Grading Option:** Graded with Option

**Offered:** FALL/SPR

**Prerequisite for:** AGST 216; AGST 232; AGST 262; AGST 342; AGST 354, SOIL 354; AGST 362; AGST 452, AGST 852, PLAS 452; ARCH 333, CNST 305; FDST 363, AGST 363; GEOL 400; PHYS 142; PHYS 142H; PLAS 458, AGRO 858, NRES 458, NRES 858, SOIL 458

**ACE:** ACE 4 Science

**Course and Laboratory Fee:** \$55

**PHYS 141H Honors: Physics for Life Sciences I**

**Prerequisites:** Good standing with the University Honors Program; MATH 102, 103, or Math Placement Exam score for MATH 106.

**Notes:** Credit toward the degree may be earned in only one of: PHYS 141, 141H and 151. Lab fee required.

**Description:** Physics in biological context, investigating the fundamental physics that govern living systems. Mechanics, fluids, heat, waves, and sound.

**Credit Hours:** 5

**Max credits per semester:** 5

**Max credits per degree:** 5

**Grading Option:** Graded

**Offered:** FALL/SPR

**Prerequisite for:** AGST 216; AGST 262; AGST 342; AGST 354, SOIL 354; AGST 362; AGST 452, AGST 852, PLAS 452; FDST 363, AGST 363; GEOL 400; PHYS 142; PHYS 142H; PLAS 458, AGRO 858, NRES 458, NRES 858, SOIL 458

**ACE:** ACE 4 Science

**Course and Laboratory Fee:** \$55

**PHYS 142 Physics for Life Sciences II**

**Prerequisites:** Grade of C, P, or better in PHYS 141 or 141H.

**Notes:** This is the second in a two-course sequence

**Description:** Introduces physics in biological context, investigating the fundamental physics that govern living systems. Topics include electricity and magnetism, circuits, optics, atomic and nuclear physics.

**Credit Hours:** 5

**Max credits per semester:** 5

**Max credits per degree:** 5

**Grading Option:** Graded with Option

**Offered:** FALL/SPR

**Prerequisite for:** BIOC 440; PHYS 343; PHYS 361

**Course and Laboratory Fee:** \$55

**PHYS 142H Honors: Physics for Life Sciences II**

**Prerequisites:** Good standing in the University Honors program; grade of C, P, or better in 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

**Grading Option:** Graded

**Offered:** FALL/SPR

**Prerequisite for:** BIOC 440; PHYS 343; PHYS 361

**Course and Laboratory Fee:** \$55

**PHYS 151 Elements of Physics**

**Prerequisites:** MATH 102 or higher; or qualifying score on Math Placement Exam for MATH 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

**Grading Option:** Graded with Option

**Prerequisite for:** AGST 109L; AGST 216; AGST 232; AGST 262; AGST 342; AGST 354, SOIL 354; AGST 362; AGST 452, AGST 852, PLAS 452; ARCH 333, CNST 305; CNST 306; FDST 363, AGST 363; PHYS 153

**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

**Grading Option:** Graded with Option

**Course and Laboratory Fee:** \$55

**PHYS 192 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

**Grading Option:** Graded with Option

**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

**Grading Option:** Graded with Option

**PHYS 211 General Physics I****Prerequisites:** MATH 106**Notes:** One year of either high school physics or algebra-based college physics is expected.**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**Grading Option:** Graded with Option**Offered:** FALL/SPR**Prerequisite for:** AGST 216; AGST 232; AGST 262; AGST 342; AGST 354, SOIL 354; AGST 362; AGST 452, AGST 852, PLAS 452; ARCH 333, CNST 305; AREN 211; ASTR 204; BSEN 244; BSEN 317; BSEN 410; ECEN 211; GEOL 400; MECH 223; MECH 223H; MECH 250; METR 205; METR 311; METR 323; 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.**Notes:** Ambitious students who are not in the Honors Program are encouraged to request permission to enroll.**Description:** For course description, see PHYS 211.**Credit Hours:** 4**Max credits per semester:** 4**Max credits per degree:** 4**Grading Option:** Graded**Offered:** FALL/SPR**Prerequisite for:** AGST 232; AGST 262; AGST 342; AGST 354, SOIL 354; AGST 362; AGST 452, AGST 852, PLAS 452; AREN 211; ASTR 204; BSEN 244; BSEN 317; ECEN 211; GEOL 400; MECH 223; MECH 223H; MECH 250; METR 205; METR 311; METR 323; PHYS 212; PHYS 212H; PHYS 221**ACE:** ACE 4 Science**PHYS 212 General Physics II****Prerequisites:** A grade of C, P, or better in PHYS 211 or PHYS 211H; MATH 107 or MATH 107H.**Description:** Continuation of PHYS 211. Electricity, magnetism, and optics.**Credit Hours:** 4**Max credits per semester:** 4**Max credits per degree:** 4**Grading Option:** Graded with Option**Offered:** FALL/SPR**Prerequisite for:** AGEN 325, BSEN 325; AREN 330; BIOC 440; BSEN 244; ECEN 306; MATL 260; MATL 360; MECH 200H; MECH 421, MECH 821, ENGR 421; PHYS 213; PHYS 213H; PHYS 222; PHYS 231; PHYS 311; PHYS 343; PHYS 361**ACE:** ACE 4 Science**PHYS 212H Honors: General Physics II****Prerequisites:** Physics major or good standing with the University Honors Program; A grade of C, P, or better in PHYS 211 or PHYS 211H; MATH 107 or MATH 107H.**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**Grading Option:** Graded**Offered:** FALL/SPR**Prerequisite for:** AGEN 325, BSEN 325; AREN 330; BIOC 440; BSEN 244; ECEN 306; MATL 260; MATL 360; MECH 200H; MECH 421, MECH 821, ENGR 421; PHYS 213; PHYS 213H; PHYS 222; PHYS 231; PHYS 311; PHYS 343; PHYS 361**ACE:** ACE 4 Science**PHYS 213 General Physics III****Prerequisites:** A grade of C, P, or better in PHYS 212 or 212H; MATH 208 or 208H.**Description:** Continuation of PHYS 212. Relativity, quantum mechanics, atoms, and nuclei.**Credit Hours:** 4**Max credits per semester:** 4**Max credits per degree:** 4**Grading Option:** Graded with Option**Offered:** FALL/SPR**Prerequisite for:** PHYS 223**PHYS 213H Honors: General Physics III****Prerequisites:** Physics major or good standing with the University Honors program; A grade of C, P, or better in PHYS 212 or 212H; MATH 208 or 208H.**Notes:** Ambitious students who are not in the Honors Program are encouraged to request permission to enroll.**Description:** For course description, see PHYS 213.**Credit Hours:** 4**Max credits per semester:** 4**Max credits per degree:** 4**Grading Option:** Graded**Offered:** FALL/SPR**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**Grading Option:** Graded with Option**Course and Laboratory Fee:** \$55**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**Grading Option:** Graded with Option**Prerequisite for:** PHYS 231**Course and Laboratory Fee:** \$55



**PHYS 223 General Physics Laboratory III****Prerequisites:** PHYS 213 or 213H or parallel.**Notes:** Optional lab to accompany PHYS 213.**Description:** Experiments in atomic and nuclear physics.**Credit Hours:** 1**Max credits per semester:** 1**Max credits per degree:** 1**Grading Option:** Graded with Option**Course and Laboratory Fee:** \$55**PHYS 231 Electrical and Electronic Circuits****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**Grading Option:** Graded with Option**Course and Laboratory Fee:** \$55**PHYS 292 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**Grading Option:** Graded with Option**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**Grading Option:** Graded with Option**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**Grading Option:** Graded with Option**ACE:** ACE 10 Integrated Product**Course and Laboratory Fee:** \$55**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**Grading Option:** Graded with Option**PHYS 398 Undergraduate Research****Prerequisites:** Permission.**Description:** Research participation.**Credit Hours:** 1-6**Min credits per semester:** 1**Max credits per semester:** 6**Max credits per degree:** 12**Grading Option:** Graded with Option**PHYS 401 Computational Physics****Crosslisted with:** PHYS 801**Prerequisites:** A grade of P, C or better in PHYS 311.**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**Grading Option:** Graded with Option**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.**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**Grading Option:** Graded with Option**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**Grading Option:** Graded with Option**PHYS 441 Experimental Physics I****Crosslisted with:** PHYS 841**Prerequisites:** PHYS 213, 223 and 231**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**Grading Option:** Graded with Option**Prerequisite for:** PHYS 442, PHYS 842**ACE:** ACE 10 Integrated Product**Course and Laboratory Fee:** \$55**PHYS 442 Experimental Physics II****Crosslisted with:** PHYS 842**Prerequisites:** PHYS 441/841 or permission**Notes:** Lab fee required.**Description:** Continuation of PHYS 441/841.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded with Option**Prerequisite for:** PHYS 443, PHYS 843**Course and Laboratory Fee:** \$55

**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**Grading Option:** Graded with Option**Course and Laboratory Fee:** \$55**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**Grading Option:** Graded with Option**PHYS 452 Optics and Electromagnetic Waves****Crosslisted with:** PHYS 852**Prerequisites:** A grade of P, C or better in 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**Grading Option:** Graded with Option**PHYS 461 Quantum Mechanics****Crosslisted with:** PHYS 861**Prerequisites:** A grade of P, C or better in PHYS 213 and 311.**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**Grading Option:** Graded with Option**PHYS 462 Atoms, Nuclei, and Elementary Particles****Crosslisted with:** PHYS 862**Prerequisites:** A grade of P, C or better in PHYS 461**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**Grading Option:** Graded with Option**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**Grading Option:** Graded with Option**PHYS 492 Special Topics in Physics****Crosslisted with:** PHYS 892**Prerequisites:** PHYS 213 and permission.**Description:** Topics vary.**Credit Hours:** 1-6**Min credits per semester:** 1**Max credits per semester:** 6**Max credits per degree:** 6**Grading Option:** Graded with Option**PHYS 499 Undergraduate Thesis****Prerequisites:** Permission.**Description:** Independent research leading to a thesis.**Credit Hours:** 1-3**Min credits per semester:** 1**Max credits per semester:** 3**Max credits per degree:** 6**Grading Option:** Graded with Option**PHYS 499H Honors Undergraduate Thesis****Prerequisites:** Permission.**Description:** Independent research leading to a thesis.**Credit Hours:** 1-3**Min credits per semester:** 1**Max credits per semester:** 3**Max credits per degree:** 6**Grading Option:** Graded with Option

## 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

- Make predictions using mathematical, statistical, and scientific modeling methods
- Conduct and present research to large and small groups
- Apply mathematical and scientific skills to solve real-world problems
- Analyze and explain data
- Collaborate with a team to develop solutions
- Compose convincing arguments and present logical information
- Comprehend and critically evaluate complex information
- Define problems and identifying causes
- Design and implement research experiments
- Develop and defend evidence based arguments
- Communicate results of scientific experiments to scientific and non-scientific audiences
- Provide a creative, inquisitive approach to problem-solving
- Read, understand, and critically review scientific information
- Understand and practice proper laboratory safety procedures
- Understand and use proper laboratory and technical skills and instruments

### Jobs of Recent Graduates

- Battery Technician, Duncan Aviation – Lincoln, NE
- Data Analyst, Changing the Present – Middlesex, NY
- Lab Assistant, Neogen – Lincoln, NE
- Plant Operator, Nebraska Public Power District – Brownville, NE
- Software Engineer, HydroGreen – Sioux Falls, SD

- Technical Engineer, Northrop Grumman – Los Angeles, CA
- Science Teacher, Lincoln Public Schools – Lincoln, NE
- Process Engineer I, Garmin – Olathe, KS
- Systems Programmer, Bryan Health – Lincoln, NE
- Technician, JA Woollam – Lincoln, NE

## Internships

- Intern, UNL Holland Computing - Lincoln NE

## Graduate & Professional Schools

- Master's Degree, Mathematics, University of Nebraska - Lincoln – Lincoln, NE
- Master's Degree, Mechanical Engineering, University of Texas - Dallas – Richardson, TX
- Master's Degree, Science Teaching, University of Nebraska - Lincoln – Lincoln, NE
- Doctoral Degree, Condensed Matter Physics, Rutgers University – New Brunswick, NJ
- Doctoral Degree, Physics, University of Nebraska - Lincoln – Lincoln, NE
- Doctoral Degree, Physics, University of Colorado - Boulder – Boulder, CO
- Doctoral Degree, Physics, Brown University – Providence, RI
- Doctoral Degree, Space Science Instrumentation, University of Michigan – Ann Arbor, MI
- Doctoral Degree, Geophysics, California Institute of Technology – Pasadena, CA
- Doctoral Degree, Astronomy, University of California - Berkeley – Berkeley CA