The Department of Physics offers the following undergraduate and graduate programs. Specific requirements for these programs are listed within this Department of Physics section in the following order:

**Undergraduate Major (B.S.)**
- Physics

**Undergraduate Major (B.A.)**
- Physics
- Physics-Teaching

**Minors**
- Nanoscience and Nanotechnology
- Physics

**Program Certificate**
- Physics Teaching

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

**Bachelor of Science Degree Program**

**Emphasis-B.S. Physics Major Honors Research**

**Emphasis-Honors Research**

Students who complete a sustained research project in physics may be invited to do Honors Research. Students must first complete 4 credit hours of PHYSICS 3000 (880:180) Undergraduate Research in Physics and then 1 credit hour of PHYSICS 4990 Senior Thesis.

**Physics Major**

The B.S. Physics major requires a minimum of 126 total hours to graduate. This total includes Liberal Arts Core requirements and the following specified major requirements, plus electives to complete the minimum of 126 hours.

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

**Required**

<table>
<thead>
<tr>
<th>Mathematics:</th>
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<tbody>
<tr>
<td>MATH 1420 (800:060)</td>
<td>Calculus I</td>
</tr>
<tr>
<td>MATH 1421 (800:061)</td>
<td>Calculus II</td>
</tr>
<tr>
<td>MATH 2422 (800:062)</td>
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<table>
<thead>
<tr>
<th>Physics:</th>
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<tbody>
<tr>
<td>PHYSICS 1100</td>
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<tr>
<td>PHYSICS 1701 (880:130)</td>
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<td>PHYSICS 1702 (880:131)</td>
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<td>PHYSICS 2300 (880:132)</td>
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<td>PHYSICS 2700</td>
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<tr>
<td>PHYSICS 3000 (880:180)</td>
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<tr>
<td>or PHYSICS 3500 (880:184)</td>
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<td>PHYSICS 3700 (880:187)</td>
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<tr>
<td>PHYSICS 4100/5100 (880:137g)</td>
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<tr>
<td>PHYSICS 4110/5110 (880:138g)</td>
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<tr>
<td>PHYSICS 4300/5300 (880:152g)</td>
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<tr>
<td>PHYSICS 4600/5600 (880:166g)</td>
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<tr>
<td>PHYSICS 4860/5860 (880:150g)</td>
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<tr>
<td>PHYSICS 4900/5900 (880:136g)</td>
</tr>
</tbody>
</table>

**Electives**

- Physics, Natural Science, or Math Electives * |

**Total Hours** | 59

* Students have the option to design an area of professional concentration by the appropriate choice of elective courses in Physics (or another Natural Science), or Mathematics. Electives must be mathematics or science courses that count toward a major of the department offering the course. Electives should be selected with the advice of an academic adviser in Physics.

**Bachelor of Arts Degree Program**

**Emphasis-B.A. Physics Major-Teaching Honors Research**

**Emphasis-Honors Research**

Students who complete a sustained research project in physics education may be invited to do Honors Research. Students must first complete 4 credit hours of PHYSICS 3000 (880:180) Undergraduate Research in Physics and then 1 credit hour of PHYSICS 4990 Senior Thesis.
Physics Major

The B.A. Physics Major requires a minimum of 120 hours to graduate. The B.A. Physics Major is suitable for a student seeking a background in physics with less specialization and mathematical rigor than in the B.S. degree in physics. It is especially appropriate for students with interdisciplinary interests who intend to pursue a career in, for example, computer science, medicine, earth/environmental science, business, or law. It requires fewer courses in physics and mathematics than the B.S. major programs and provides an opportunity to take courses in other science areas of interest.

Physics:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
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<tbody>
<tr>
<td>PHYSICS 1100</td>
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<tr>
<td>PHYSICS 1701 (880:130)</td>
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</tr>
<tr>
<td>PHYSICS 1702 (880:131)</td>
<td>Physics II for Science and Engineering</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 2300 (880:132)</td>
<td>Physics III: Theory and Simulation</td>
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</tr>
<tr>
<td>PHYSICS 4100/5100</td>
<td>Modern Physics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 4110/5110 (880:138g)</td>
<td>Modern Physics Laboratory</td>
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Mathematics:

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<th>Hours</th>
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<td>MATH 1420 (800:060)</td>
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<tr>
<td>MATH 1421 (800:061)</td>
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Electives:

<table>
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<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics or non-physics science courses from the College of Humanities, Arts and Sciences *</td>
<td></td>
<td>4</td>
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</table>

Total Hours 46

* Excluding all 820:xxx and mathematics below MATH 1420 (800:060).

Teaching:

<table>
<thead>
<tr>
<th>Course</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>TEACHING 3129</td>
<td>Secondary and Special-Area Classroom Management</td>
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Physics:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
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<td>First-Year Projects in Physics</td>
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</tr>
<tr>
<td>PHYSICS 1701 (880:130)</td>
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<td>4</td>
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<tr>
<td>PHYSICS 1702 (880:131)</td>
<td>Physics II for Science and Engineering</td>
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</tr>
<tr>
<td>PHYSICS 2300 (880:132)</td>
<td>Physics III: Theory and Simulation</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 4080/5080</td>
<td>Resources for Teaching Physics</td>
<td>2</td>
</tr>
<tr>
<td>PHYSICS 4100/5100 (880:137g)</td>
<td>Modern Physics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 4110/5110 (880:138g)</td>
<td>Modern Physics Laboratory</td>
<td>2</td>
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</tbody>
</table>

Electives

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics: all 3000+ level courses</td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

It is recommended that sufficient work including current curricula should be taken for licensure approval in a second area. Common teaching combinations are physics-chemistry or physics-mathematics. Completion of this major will satisfy the requirements of the Iowa Department of Education for licensure.

Minors

Nanoscience and Nanotechnology Minor

Required

Chemistry and Biochemistry: 5-8
- Select one of the following:
  - CHEM 1110 (860:044) & CHEM 1120 (860:048) General Chemistry I and General Chemistry II
  - CHEM 1130 (860:070) General Chemistry I-II

Physics:

- PHYSICS 1511 (880:054) General Physics I
- or PHYSICS 1701 (880:130) Physics I for Science and Engineering
- PHYSICS 1512 (880:056) General Physics II
- or PHYSICS 1702 (880:131) Physics II for Science and Engineering

- PHYSICS 4200/5200 (880:144g) Nanoscience
- or CHEM 4200/5200 (860:144g) Nanoscience
- PHYSICS 4210/5210 (880:148g) Nanotechnology
Physics Minor

Required

Physics:
Select one of the following:

- PHYSICS 1511 (880:054) & PHYSICS 1512 (880:056) General Physics I and General Physics II (required)
- PHYSICS 1701 (880:130) & PHYSICS 1702 (880:131) Physics I for Science and Engineering and Physics II for Science and Engineering (required)

Electives:

- 3000-level electives in Physics, with no more than 3 hours earned in the following:
  - PHYSICS 3000 (880:180) Undergraduate Research in Physics (and/or)
  - PHYSICS 4450/5450 (880:185g) Laboratory Projects

Total Hours 20

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

Program Certificate

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

Physics Teaching Certificate

Completion of the certificate for the majors mentioned below meets the requirements of the State of Iowa Grades 5-12 Physics Teaching Endorsement.

Required:

Physics:

- PHYSICS 1511 (880:054) or PHYSICS 1701 (880:130) General Physics I for Science and Engineering (required)
- PHYSICS 1512 (880:056) or PHYSICS 1702 (880:131) General Physics II for Science and Engineering
- PHYSICS 4080/5080 Resources for Teaching Physics
- SCI ED 3300/5300 (820:190g) Orientation to Science Teaching

Electives chosen from the following: 3-5

* A maximum of 2 hours are allowed.

Courses

Basic laws and concepts of physics introduced and demonstrated through operation of everyday devices and systems. Emphasis on understanding physical principles behind working of modern technologies and interplay between science and technology. Students may not earn credit in both PHYSICS 1400 (880:011) and PHYSICS 1000 (880:012). Prerequisite(s): student must have satisfied university entrance requirements in English and Mathematics. (Fall and Spring)

PHYSICS 1100. First-Year Projects in Physics — 1 hr.
An introduction to the basic elements of physics research and applications. Students will complete a series of projects designed to integrate theory, measurement and computation to create instruments and devices that interact with the physical world. In doing so, students will learn how to create and control electro-mechanical devices and gain experience in techniques used in both industry and research. Prerequisite(s) or corequisite(s): PHYSICS 1701 (880:130), Physics I for Science and Engineering, or the consent of the department head. (Fall)

Energy; temperature and heat; waves and sound; electricity and magnetism; light and color; and atomic and nuclear structure of matter. Emphasis on observation, interpretation, and conceptual understanding of physical phenomena. Discussion, 3 periods; lab, 2 periods. Students may not earn credit in both PHYSICS 1400 (880:011) and PHYSICS 1000 (880:012). Prerequisite(s): student
must have satisfied university entrance requirements in English and Mathematics. (Fall and Spring)

**PHYSICS 1511 (880:054). General Physics I — 4 hrs.**
Algebra-based introductory course covering Newtonian mechanics, gravitation, and thermal physics. Emphasis on conceptual understanding of physical principles through group investigations and lab activities. Discussion/lab, 5 periods. Prerequisite(s): MATH 1130 (800:044) or MATH 1140 (800:046) or MATH 1150 (800:048) or MATH 1420 (800:060) or equivalent, or a satisfactory ALEKS score. (Fall and Spring)

**PHYSICS 1512 (880:056). General Physics II — 4 hrs.**
Algebra-based introductory course covering electricity, magnetism, optics, and modern physics. Emphasis on conceptual understanding of physical principles through group investigations and lab activities. Discussion/lab, 5 periods. Prerequisite(s): PHYSICS 1511 (880:054) or PHYSICS 1701 (880:130). (Fall and Spring)

**PHYSICS 1701 (880:130). Physics I for Science and Engineering — 4 hrs.**
Calculus-based introductory course covering Newtonian mechanics, gravitation, and thermal physics. Lab activities. Discussion/lab, 5 periods. Prerequisite(s): one year of high school physics or equivalent. Prerequisite(s) or corequisite(s): MATH 1420 (800:060). (Fall)

**PHYSICS 1702 (880:131). Physics II for Science and Engineering — 4 hrs.**
Calculus-based introductory course covering electricity, magnetism, and optics. Lab activities. Discussion/lab, 5 periods. Prerequisite(s): PHYSICS 1511 (880:054) (minimum grade of B) or PHYSICS 1701 (880:130). Prerequisite(s) or corequisite(s): MATH 1421 (800:061). (Spring)

**PHYSICS 1800 (880:080). Projects in Basic Robotics and Sensors — 1 hr.**
Assembly of a mini-sumo robot, with motor, sensors and microprocessor. Implement line following. Explore modifications to the sumo hardware and software that will permit successful participation in a sumo robotics competition at the end of the course. Lab, 2 periods. Prerequisite(s) or corequisite(s): PHYSICS 1511 (880:054) and PHYSICS 1512 (880:056), or PHYSICS 1701 (880:130) and PHYSICS 1702 (880:131), or MATH 1140 (800:046) and TECH 1037 (330:037), or CS 1410 (810:041) or CS 1510 (880:051). (Variable)

**PHYSICS 2300 (880:132). Physics III: Theory and Simulation — 3 hrs.**
Calculus-based course covering the more advanced topics in introductory physics. Emphasis on developing analytical and computational skills needed to study physics at a more advanced level. Topics include Newtonian mechanics and applications, Maxwell’s equations and applications. Prerequisite(s): PHYSICS 1702 (880:131). (Fall)

**PHYSICS 2700. Mathematical Methods of Physics — 3 hrs.**
Introduction to the mathematical methods used in upper-level Physics courses, illustrated with applications from all areas of Physics. Applications will illustrate electrodynamics, thermodynamics, classical mechanics and quantum mechanics. Prerequisite(s): MATH 1420 (800:060); MATH 1421 (800:061); MATH 2422 (800:062); PHYSICS 1701 (880:130); PHYSICS 1702 (880:131); PHYSICS 2300 (880:132). (Spring)

**PHYSICS 3000 (880:180). Undergraduate Research in Physics — 1-6 hrs.**
Research activities under direct supervision of sponsoring staff members or at a national laboratory. Should normally be taken after the first year of the major. Successful completion of the research experience requires both a written and oral report. Prerequisite(s): minimum overall 2.50 GPA; consent of department. (Fall and Spring)

**PHYSICS 3179 (880:179). Cooperative Education.**
Applied physics internship under PHYSICS 3179 (880:179) should be taken during the junior or senior year. If unable to do so, the internship may be done under PHYSICS 3500 (880:184) with consent of department. Successful completion of either PHYSICS 3179 (880:179) or PHYSICS 3500 (880:184) requires both a written and an oral report. Offered on credit/no credit basis only. (Fall and Spring)

**PHYSICS 3500 (880:184). Internship in Applied Physics — 1-3 hrs.**
Departmentally approved work in applied physics (at an industrial, medical, or government laboratory) followed by oral and written reports given on completed work. Offered on credit/no credit basis only. Prerequisite(s): minimum overall 2.50 GPA; consent of department. (Fall and Spring)

**PHYSICS 3700 (880:187). Physics Seminar — 1 hr.**
Seminar course covering aspects important for life after graduation. Participation in physics colloquia; oral report on research topic or internship, drafting resume/CV, interview, perform job and graduate school search. Prerequisite(s): PHYSICS 4100/5100 (880:137g). (Fall)

**PHYSICS 4050/5050 (880:140g). Optical Science — 3 hrs.**
An introduction to optics and applied optics. Topics include: geometric optics, wave optics, quantum optics, and introductions to lasers and optical spectroscopy. Discussion, 2 periods; lab, 2 periods. Prerequisite(s): PHYSICS 1512 (880:056) or PHYSICS 1702 (880:131); junior standing or consent of department head. (Fall)

**PHYSICS 4080/5080. Resources for Teaching Physics — 2 hrs.**
A physics course that focuses on topics recommended for high school physics programs, with an emphasis on various physics education resources in the context of science education initiatives. This course is designed for both current science teachers and science education undergraduates. Prerequisite(s): PHYSICS 1511 (880:054) or PHYSICS 1701 (880:130); PHYSICS 1512 (880:056) or PHYSICS 1702 (880:131); junior standing. (Spring)

**PHYSICS 4100/5100 (880:137g). Modern Physics — 4 hrs.**
Special relativity; quantum phenomena; wave-particle duality; atomic and nuclear structure; properties of solids, interaction of radiation with matter; and elementary particles. Prerequisite(s): PHYSICS 1702 (880:131); junior standing. (Spring)

**PHYSICS 4110/5110 (880:138g). Modern Physics Laboratory — 2 hrs.**
Experiments on interactions of photons and electrons; mass and charge of electrons; atomic spectroscopy; nuclear detection and spectroscopy; spin resonance; and properties of solids. Requires detailed lab reports, including error analysis. Prerequisite(s): junior standing. Prerequisite(s) or corequisite(s): PHYSICS 4100/5100 (880:137g). (Spring)

**PHYSICS 4200/5200 (880:144g). Nanoscience — 3 hrs.**
Study of nanoscale materials and processes, with emphasis on the preparation and characterization of materials with nanometer scale dimensions; investigation of how nanoscale dimensions produce unique chemical and physical properties; nanoscale microscopy and spectroscopic methods of investigation. Prerequisite(s):
PHYSICS 4210/5210 (880:148g). Nanotechnology — 3 hrs.
Study of nanoscale materials and processes, with emphasis on the current and potential future applications of materials with distinctive properties due to their nanometer scale dimensions; nanoporous materials; discussion of the broader implications of nanotechnology in areas such as government policy, occupational safety and medical technology. Prerequisite(s): CHEM 1110 (860:044) and CHEM 1120 (860:048) (or CHEM 1130 (860:070)); PHYSICS 1511 (880:054) or PHYSICS 1701 (880:070); PHYSICS 1512 (880:056) or PHYSICS 1702 (880:131); junior standing. [Same as CHEM 4210/5210 (860:144g)] (Fall)

Introduction to the theory and applications of analog and digital electronics utilizing the Digital Electronics curriculum from the nationally certified Project Lead The Way (PLTW) curriculum. Especially intended for science and technology K-12 education majors to become certified PLTW teachers of this course. Prerequisite(s): PHYSICS 1511 (880:054) or PHYSICS 1400 (880:011) or PHYSICS 1701 (880:130); junior standing. (Same as TECH 4290/5290) (Spring)

PHYSICS 4300/5300 (880:152g). Introduction to Electronics — 4 hrs.
Introduction to DC and AC circuits; electrical measurements, circuit theory and circuit simulation; analog and digital circuits; energy generation and efficiency. Discussion, 2 periods; lab, 4 periods. Prerequisite(s): PHYSICS 1512 (880:056) or PHYSICS 1702 (880:131); MATH 1421 (800:061); junior standing. (Fall)

Introduction to computer interfacing, instrument control, and data acquisition. Utilization of industry standard software and microcontrollers to acquire and process data, process signals, and perform feedback control of physical systems. Prerequisite(s): PHYSICS 1511 (880:054) and PHYSICS 1512 (880:056), or PHYSICS 1701 (880:130) and PHYSICS 1702 (880:131); junior standing. (Odd Springs)

PHYSICS 4450/5450 (880:185g). Laboratory Projects — 1-3 hrs.
Experimental activities to meet individual needs and interests not normally included in other courses. Maximum of 3 hours may be applied to a physics major or minor. Prerequisite(s): junior standing; consent of department. (Fall and Spring)

Vectors and kinematics; force and motion; work and energy; Lagrange's equations; gravity; oscillations; rigid-body motion; and accelerated reference frames. Prerequisite(s): MATH 1420 (800:060); MATH 1421 (800:061); PHYSICS 1701 (880:130); PHYSICS 1702 (880:131); PHYSICS 2300 (880:132); PHYSICS 2700; junior standing. Corequisite(s): MATH 2422 (800:062). (Fall)

PHYSICS 4700/5700 (880:167g). Electrodynamics — 4 hrs.
Vector calculus. Electrostatic fields and dielectrics; magnetic fields, magnetic forces, and magnetic materials; Maxwell's equations and electromagnetic waves. Prerequisite(s): MATH 2422 (800:062); PHYSICS 2300 (880:132); PHYSICS 2700; PHYSICS 4600/5600 (880:166g); junior standing. (Odd Springs)

Structural, thermal, and electronic properties of materials; applications to modern devices. Discussion, 2 periods; lab, 2 periods. Prerequisite(s): PHYSICS 4100/5100 (880:137g); PHYSICS 4110/5110 (880:138g); junior standing. (Odd Falls)

PHYSICS 4800/5800 (880:172g). Quantum Mechanics — 4 hrs.
Schrödinger equation for several systems: spin and angular momentum; identical particles; perturbation theory; WKB approximation; and scattering. Prerequisite(s): PHYSICS 2700; PHYSICS 4100/5100 (880:137g); PHYSICS 4600/5600 (880:166g); junior standing. (Even Springs)

PHYSICS 4860/5860 (880:150g). Computational Physics — 3 hrs.
Computer simulations and numerical solutions of behaviors of important physical systems, emphasizing those that are very difficult or impossible to analyze by traditional means, for example, nonlinear oscillators or phase transitions in the Ising Model. Discussion, 2 periods; lab, 2 periods. Prerequisite(s): PHYSICS 2300 (880:132); PHYSICS 2700; PHYSICS 4100/5100 (880:137g); PHYSICS 4600/5600 (880:166g); junior standing. (Spring)

General principles of classical thermodynamics and applications (e.g., to first-order phase transitions); general principles of statistical mechanics and applications (e.g., to the classical ideal gas). Prerequisite(s): PHYSICS 2300 (880:132); PHYSICS 2700; PHYSICS 4100/5100 (880:137g); junior standing. (Spring)

PHYSICS 4950/5950 (880:189g). Readings in Physics — 1-3 hrs.
Readings/problems in areas of physics (or related interdisciplinary areas) not normally covered in other courses. Maximum of 3 hours may be applied to a physics major or minor. Prerequisite(s): junior standing; consent of department. (Variable)

PHYSICS 4990. Senior Thesis — 1 hr.
Senior Thesis. Open only to students pursuing the B.S. Physics Honors Research Emphasis or the B.A. Physics-Teaching Honors Research Emphasis. Prerequisite(s): consent of the department head. (Fall, Spring, Summer)

Computer simulation and visualization of physical systems. Students will code, debug, and run basic simulations in C++ as well as more sophisticated simulations with other tools, including parallel computing. Prerequisite(s): CS 1160 (810:036) and PHYSICS 4860/5860 (880:150g), or MATH 3440/5440 (800:176g) and CS 1160 (810:036), or consent of instructor. (Variable)

PHYSICS 6299 (880:299). Research.
Prerequisite(s): consent of department. (Variable)

Introduction to computer interfacing, instrument control, and data acquisition. Discussion of digital signal processing and utilization of industry-standard software platforms in laboratory activities. Prerequisite(s): PHYSICS 2300 (880:132); PHYSICS 4300/5300 (880:152g). (Variable)

PHYSICS 6500 (880:250). Special Problems in Physics — 1-6 hrs.
Credit determined at registration. Problems selected according to needs of students. Prerequisite(s): consent of department. (Variable)
Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Helvetica was used instead of Arial.

The editor may contact Leepfrog for a draft with the correct fonts in place.