1. DU Common Curriculum:
   - First-Year Seminar
   - 8 credits of Writing and Rhetoric
   - 12 credits of a foreign language (or demonstrated proficiency)
   - 16 credits of Ways of Knowing, including
     - 8 credits of Analytical Inquiry: Society and Culture (AI2)
     - 8 credits of Scientific Inquiry: Society and Culture (SI2)
   - Advanced Seminar

2. Calculus I, II, and III (MATH 1951, 1952, 1953); Introduction to Differential Equations (MATH 2070); and Calculus of Several Variables (MATH 2080). Completing these courses fulfills the requirements for a minor in mathematics for most students. Students transferring in 12 credits of AP or IB Calculus need one more math course for the minor, as DU policy requires 50% of major and minor credit hours to be taken at DU.

3. University Physics I, II, III, and lab (PHYS 1211, 1212, 1213)

4. One of the following pairs of science breadth courses:
   - General Chemistry I and lab (CHEM 1010 and 1240)
   - Concepts: Physiological Systems and lab (BIOL 1010 and 1020)
   - Concepts: Cellular and Molecular Biology and lab (BIOL 1011 and 1021)

5. At least 45 quarter hours of physics coursework at 2000 level or above. This program must include the following:
   - Modern Physics I and II (PHYS 2251, 2252)
   - Modern Lab (PHYS 2260)
   - Uncertainty and Error Analysis (PHYS 2259)
   - Intermediate Lab I and II (PHYS 2311, 2312)
   - Analytical Mechanics I and II (PHYS 3510, 3520)
   - Quantum Physics I and II (PHYS 3111, 3112)
   - Electromagnetism I and II (PHYS 3611, 3612)
   - Thermal Physics (PHYS 3841)
   - Senior Seminar (PHYS 3100)
These required courses total 45 credits, so no physics electives are required for the BS. However, we encourage students to take other physics courses as their interests and schedule permit. Note that students pursuing concentrations (see pages 5–6 of this document) will take at least 11 extra credits beyond these 45.

6. Two minors, at least one of which is in a BS degree-granting department. Completing the mathematics courses listed in requirement #2 fulfills this second condition.

(continued)
DU Physics and Astronomy BS Degree Requirements, continued

7. A senior thesis, **due by April 1 of senior year**. The required Senior Seminar (PHYS 3100), offered each fall, gives students the background and framework necessary to write the thesis paper. A student may enroll in Senior Seminar in any year after beginning a research project; this course must be completed by the fall of the senior year as shown in the timeline below. BS students will normally also enroll in Independent Study (PHYS 3991) or Independent Research (PHYS 3995) as part of their work toward the senior thesis. Double majors must complete a physics-related thesis for the physics BS, but joint thesis projects between physics and other fields will be considered on a case-by-case basis. A senior thesis report should approximate a document that could be submitted for publication to a research journal.

**Senior thesis timeline**

- **Winter quarter of junior year**: Student should begin investigating possible thesis advisors and research projects.
- **Spring quarter of junior year**: Student selects thesis advisor and presents a plan to his/her academic advisor during advising week.
- **Summer after junior year**: Student should consider doing research in the summer (whether at DU or in an external REU program). Research done outside DU may be used as the basis for a senior thesis, but the student must still identify a local thesis advisor.
- **Fall quarter of senior year**: Student enrolls in the Senior Seminar (PHYS 3100, offered each fall). This course will help the student develop the motivation and research background for his/her project, as well as provide some background and training in research methods and techniques. Student also applies for spring graduation at this time: [http://www.du.edu/registrar/graduation/graduationapp.html](http://www.du.edu/registrar/graduation/graduationapp.html)
- **Winter break of senior year**: Student should consider using this time to complete his/her research project so that winter quarter may be spent finalizing the thesis paper.
- **Winter quarter of senior year**: Student presents draft of thesis report to academic and research advisors during advising week. Suggested length is at least 8500 words. Student may also choose to register to present his/her research at the undergraduate Symposium in early May (required for distinction or for completion of a PINS award).
- **April 1 of senior year**: Student posts the final thesis report to his/her Portfolio site.
- **May of senior year**: Student may present a poster or talk at the undergraduate Symposium.
A graduating BS student may be awarded distinction in the Physics major if he or she meets the following requirements:

1. Overall PHYS and MATH GPA of at least 3.25

2. Twelve credit hours of any reasonable combination of the following:
   - PHYS 3991 *Independent Study* and/or PHYS 3995 *Independent Research* as part of senior thesis work
   - PHYS 4750 *Seminar in Physics* (undergraduates are eligible to enroll in this course with instructor approval)
   - other physics courses at the 3000+ level beyond the BS requirements

3. A senior thesis report that approximates a journal-submission quality document

4. A poster or other presentation of senior thesis work at DU’s Undergraduate Symposium (held annually in early May)

5. Community service or public outreach experience (can include SPS participation)

Individualized distinction options can be proposed for approval by the Undergraduate Committee.
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<thead>
<tr>
<th></th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
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<tbody>
<tr>
<td><strong>Fr</strong></td>
<td>PHYS 1200 <em>Physics Prep</em> (2)</td>
<td>PHYS 1211 <em>Univ. Phys. I</em> (5)</td>
<td>PHYS 1212 <em>Univ. Phys. II</em> (5)</td>
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<tr>
<td></td>
<td>MATH 1951 <em>Calculus I</em> (4)</td>
<td>MATH 1952 <em>Calculus II</em> (4)</td>
<td>MATH 1953 <em>Calculus III</em> (4)</td>
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<td>FSEM 1111 <em>First Year Seminar</em> (4)</td>
<td>WRIT 1122 <em>Acad. Writing</em> (4)</td>
<td>WRIT 1133 <em>Acad. Writing</em> (4)</td>
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<td>CHEM 1240 <em>Gen. Chem. Lab</em> (1)</td>
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<td><em>Foreign Language</em> (4)</td>
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<td><strong>So</strong></td>
<td>PHYS 1213 <em>Univ. Phys. III</em> (5)</td>
<td>PHYS 2251 <em>Mod. Phys. I</em> (4)</td>
<td>PHYS 2252 <em>Mod. Phys. II</em> (3)</td>
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<td></td>
<td><em>AI2</em> (4) 2</td>
<td>PHYS 2259 <em>Uncertainty</em> (1)</td>
<td>PHYS 2260 <em>Modern Lab</em> (1)</td>
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<td></td>
<td><em>SI2</em> (4) 2</td>
<td>MATH 2070 <em>Diff. Eqns.</em> (4)</td>
<td>MATH 2080 <em>Multivar.</em> (4)</td>
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<td><em>Minor Requirement/Elective</em> (4)</td>
<td><em>AI2</em> (4) 2</td>
<td><em>Minor or concentration requirements as needed</em></td>
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<td><em>SI2</em> (4) 2</td>
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<td><strong>Ju</strong></td>
<td>PHYS 2311 <em>Intermed. Lab I</em> (3)</td>
<td>PHYS 2312 <em>Intermed. Lab II</em> (3)</td>
<td>PHYS 3520 <em>Analyt. Mech. II</em> (4)</td>
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<td><em>ASEM</em> <em>Advanced Seminar</em> (4)</td>
<td>PHYS 3510 <em>Analyt. Mech. I</em> (4)</td>
<td>PHYS 3612 <em>E&amp;M II</em> (4)</td>
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<td><em>This is the best quarter for physics majors to study abroad.</em></td>
<td>PHYS 3611 <em>E&amp;M I</em> (4)</td>
<td>PHYS 3612 <em>E&amp;M II</em> (4)</td>
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<td><strong>Se</strong></td>
<td>PHYS 3100 <em>Senior Seminar</em> (2)</td>
<td>PHYS 3111 <em>Quantum Physics I</em> (4)</td>
<td>PHYS 3112 <em>Quantum Physics II</em> (4)</td>
</tr>
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<td><em>Minor or concentration requirements as needed</em></td>
<td><em>Minor or concentration requirements as needed</em></td>
<td>PHYS 3995 <em>Indep. Research</em> 5</td>
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1 BIOL 1010 and 1020 (normally offered in fall) or BIOL 1011 and 1021 (normally offered in winter) may be taken instead of CHEM 1010 and 1240.

2 *AI2* and *SI2* courses may be taken in any order.

3 PHYS 3510/3520 *Analytical Mechanics I,II* and PHYS 3611/3612 *Electromagnetism I/II* are offered every other year. PHYS 3111/3112 *Quantum Physics I/II* and PHYS 3841 *Thermal Physics* are offered in the alternating years. Either set of courses may be taken first.

4 Physics electives are not required, but PHYS 2110 *Intro Computational Physics* and PHYS 3711 *Optics* are strongly recommended. Undergraduates may also enroll in graduate-level courses in physics and biophysics (BIOP) with special permission.

5 BS students will normally enroll in PHYS 3991 *Independent Study* or PHYS 3995 *Independent Research* as part of their work toward the senior thesis. Credits for these courses are variable.
Concentrations in Physics Major

As a part of its BS Degree in Physics, the Department of Physics and Astronomy offers the following Concentrations in Physics Major:

- **Concentration in Biological Physics**
- **Concentration in Computational Physics**
- **Concentration in Nanophysics**

**General Conditions:**
All three concentrations are only available in combination with the BS degree. The concentrations require at least additional 11 credit hours (i.e. in addition to the 45 credit hours of 2000+ PHYS coursework already required), which may include some courses in other departments. Other courses may be substituted for the concentration as approved by the Department on a case-by-case basis. The Senior Thesis must be done in a field related to the Concentration (as approved by the Department); the Senior Thesis is normally associated with 8 credit hours of PHYS 3995 Independent Research; for all Concentration, it requires at minimum PHYS 3100 Senior Seminar (2 credit hours) in a field related to the Concentration (Senior Seminar will be preferably taken in the Fall Quarter of the Senior year).

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Biological Physics</th>
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<tbody>
<tr>
<td><strong>A:</strong> Required PHYS courses:</td>
<td>PHYS 4100 Foundations of Biophysics (cross-listed with BIOP 4100) (4 credits)</td>
</tr>
</tbody>
</table>
| **B:** A minimum of 7 additional credit hours from the following list: | PHYS 2110 Introduction to Computational Physics (3 credits)  
PHYS 2300 Physics of the Body (3 credits)  
PHYS 2341 Medical Imaging Physics (3 credits)  
PHYS 3711 Optics (4 credits)  
BIOL 2120 Cell Structure and Function (4 credits) (prerequisites: BIOL 1010 and 1011 and CHEM 1010)  
BIOL 3150 Intracellular Dynamics (4 credits) (prerequisite: BIOL 2120)  
BIOL 3160 Biophysics: Ion Channels and Disease (3 credits) (prerequisite: BIOL 2120)  
BIOL 3640 Introductory Neurobiology (4 credits) (prerequisite: BIOL 2120)  
BIOP 4150 Cellular Biophysics (4 credits)  
CHEM 2011 Analysis Equilibrium Systems (3 credits) (prerequisite CHEM 1010)  
CHEM 3610 Physical Chemistry I (3 credits) (prerequisite CHEM 1010 and CHEM 2011) |

Note: At least one course from this list must be a BIOL or CHEM course.
### Computational Physics

<table>
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<th>Concentration</th>
<th>Courses</th>
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<tr>
<td><strong>A:</strong> Required physics courses:</td>
<td>PHYS 2110 Intro to Computational Physics (3 credits)</td>
</tr>
</tbody>
</table>
| **B:** A minimum of 8 additional credit hours from the following list: | COMP 1671 Intro to Computer Science I (4 credits)  
COMP 1672 Intro to Computer Science II (4 credits)  
COMP 1673 Intro to Computer Science III (4 credits) |

Note:

### Nanophysics

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<tr>
<th>Concentration</th>
<th>Courses</th>
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<tr>
<td><strong>A:</strong> Required physics courses:</td>
<td>PHYS 4411 Advanced Condensed Matter Physics I (3 credits)</td>
</tr>
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</table>
| **B:** A minimum of 8 additional credit hours from the following list: | ENGR 3200 Intro to Nanotechnology (4 credits)  
ENGR 3210 Intro Nano-Electro-Mechanics (4 credits)  
ENGR 3215 NEMS and Nanofabrication Lab (4 credits) (prerequisite ENGR 3210)  
PHYS 4100 (cross-listed with BIOP 4100 Foundations of Biophysics) (4 credits)  
PHYS 4412 Advanced Condensed Matter Physics II (3 credits) |

Note: At least one course from this list must be an ENGR course.