<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section I.</td>
<td>General Information</td>
<td>3</td>
</tr>
<tr>
<td>Section II.</td>
<td>Degree Programs in Physics</td>
<td>4</td>
</tr>
<tr>
<td>Section III.</td>
<td>Course Requirements, Acceptance Criteria, and Recommended Sequences</td>
<td>6</td>
</tr>
<tr>
<td>Section IV.</td>
<td>General Education Requirements</td>
<td>26</td>
</tr>
<tr>
<td>Section V.</td>
<td>General Guidelines</td>
<td>32</td>
</tr>
<tr>
<td>Section VI.</td>
<td>Procedures for Applying to Degree Programs</td>
<td>33</td>
</tr>
<tr>
<td>Section VII.</td>
<td>Departmental Honors and Senior Thesis</td>
<td>33</td>
</tr>
<tr>
<td>Section VIII.</td>
<td>Undergraduate Research</td>
<td>34</td>
</tr>
<tr>
<td>Section IX.</td>
<td>Advice on Graduate School</td>
<td>34</td>
</tr>
<tr>
<td>Appendix A.</td>
<td>Acceptance Criteria for Transfer Students</td>
<td>36</td>
</tr>
<tr>
<td>Appendix B.</td>
<td>Course Description</td>
<td>36</td>
</tr>
</tbody>
</table>
I. GENERAL INFORMATION

Physics is the fundamental science underlying all natural phenomena. Its elegant experiments and fundamental theories have provided much of the advancements in present day science and technology. From the smallest sub-atomic particles to the vastness of cosmic expansion, and at the intermediate scales of our lives in such areas as solid-state electronics, magnetism, superconductivity, biological function, and geologic events, physics profoundly impacts our understanding of nature and our ability to harness its secrets for the progress of human kind.

The central mission of the undergraduate program in the Department of Physics is to provide students with an outstanding educational experience consisting of comprehensive and rigorous coursework and laboratory training leading to a baccalaureate degree. The core of our major programs involves courses focused on five key topic-areas – classical mechanics, electricity and magnetism, thermal and statistical physics, modern physics including quantum mechanics and relativity, and experimental methods. In addition, our upper-level electives, research courses, and internships allow students to experience an array of specialty areas in further preparation for graduate study and future careers. Within the subjects of the curriculum, student learning is assessed in 5 general program outcome categories: basic laws of physics, critical thinking and problem solving, laboratory skills, contemporary areas of physics, and written and oral communication. As part of the overall mission of the College of Arts and Sciences, the Department also provides physics education to students majoring in other sciences, in engineering and professional programs, and to non-science majors. The Department actively advises prospective and current students on educational choices and career paths. Our faculty is vigorously engaged in research at the frontiers of physics, and is committed to excellence in teaching and mentoring at all levels of the educational program.

The Department of Physics is housed in Fronczak Hall and consists of 27 full–time faculty members, an administrative assistant, four secretaries, and a technical staff. For detailed information on the Department follow the links on the Department’s home page at www.physics.buffalo.edu.

The Department of Physics offers a B.S., B.A., and a Minor in Physics; and participates in the interdisciplinary programs which lead to a B.A. in Physics with Teaching of Science Concentration, a B.S. in Computational Physics, a B.S. in Mathematical Physics, and a B.S. in Engineering Physics. There is also a 5 year program leading to a B.S. in Computational Physics/M.S. in Physics. The required courses and the recommended sequence for each program are given in Section III. The General Education requirements that apply to the various programs are summarized in Section IV, while general guidelines for all the programs are presented in Section V.

It is necessary to apply for acceptance into any of the above programs. The acceptance criteria for students who have completed the relevant course work at U.B. are given in Section III under the heading for each program. In general, it is possible to apply for any of the programs in the first semester of the sophomore year. The procedure for applying to each program is given in Sect. VI.
The Department of Physics Honors Program and the option of doing a Senior Thesis are described in Sect. VII. Advice for students planning to do graduate work in Physics is given in Section VIII.

For general information about the programs in Physics it is best to consult with the Undergraduate Director for Physics, Professor Bernard Weinstein, 209 Fronczak Hall, (716) 645-6730, e-mail: phyugadv@buffalo.edu.

Physics majors, as well as students who intend to become physics majors, should discuss their program of study with the Undergraduate Director before registering for each semester. This is to ensure that the proper courses are being taken, and in a reasonable sequence. Students who have signed up for the Finish in Four plan are required to make an appointment to meet with their advisor during the first 3 weeks of each semester. When a student is close to graduation he or she should consult with the Undergraduate Director to make sure that all of the requirements of the Department of Physics, as well as the General Education requirements, will have been met by the proposed date of graduation. In order to graduate a student must apply for graduation in their HUB Student Center via https://myub.buffalo.edu. Applications for June 1, September 1, and February 1 graduations must be filed by February 15, June 15, and September 15, respectively.

II. DEGREE PROGRAMS IN PHYSICS

Before selecting a degree program in physics, the student should study the specific requirements carefully and discuss them with the Undergraduate Director (Prof. Weinstein). The procedure for applying to each program is given in Section VI.

The B.S. in Physics is designed for undergraduates considering professional careers as a physicist. It is strongly recommended for students planning to pursue physics Ph.D. or M.S. degrees, and careers in research and development in academia, industry, or government laboratories that focus primarily on research, advanced development, or higher education in physics.

The B.A. in Physics is designed for students who are interested in physics, but wish to have a broader education in their undergraduate years. Students who complete this program will have enough background to go on to graduate school in physics, but the program is more appropriate for students who desire a working knowledge of basic physics in order to pursue allied careers in such areas as geophysics, biophysics, science and public policy, to name a few possibilities.

The Minor in Physics provides a good secondary area of concentration for all students in science and engineering, as well as students in such areas as philosophy, history, or the arts.

The B.A. in Physics with Teaching of Science Concentrations provides the background in physics and mathematics needed for teaching physics at the high school level. It is not meant for students who wish to do graduate work in physics, but it is appropriate for graduate study in education.

The B.S. degrees in Mathematical Physics, Engineering Physics, and Computational Physics are
interdisciplinary programs that combine requirements from two major degree programs. The *Mathematical Physics* program is overseen by the Department of Physics and co-administered by the Department of Mathematics. It is designed for students who wish to pursue graduate degrees in theoretical physics or applied mathematics and careers in these areas.

The *Engineering Physics* program is overseen by the Department of Electrical Engineering and co-administered by the Department of Physics. It is designed for students whose interests center on the more fundamental aspects of engineering, or on allied areas of physics applications. It is an appropriate course of study for students whose career objectives are in applied physics, physical electronics, solid state electronics, electrical metrology, laser physics, advanced materials, and related fields. The program is such that students can pursue a graduate degree in Electrical Engineering or Applied Physics.

The B.S. in Computational Physics combines requirements from the B.S. in Physics and the B.S. in Computer Science. It is overseen by the Department of Physics and designed for students who are interested in applying advanced computer based techniques to physics research, or who wish to develop technical software. The program is such that students can pursue a graduate degree in either physics or computer science. It is also possible to pursue a 5-year program leading to the degree, *B.S in Computational Physics/M.S. in Physics*. 
III. COURSE REQUIREMENTS, ACCEPTANCE CRITERIA, AND RECOMMENDED SEQUENCES

For all of the programs described in this section students must also fulfill the requirements of the General Education Program, which are summarized in Section IV.

PHYSICS–B.S.

Acceptance Criteria: GPA of 2.0 in MTH 141–142, PHY 107–108/158

REQUIRED COURSES
CHE 101 General Chemistry
CHE 102 General Chemistry
MTH 141 College Calculus I
MTH 142 College Calculus II
MTH 241 College Calculus III
MTH 306 Introduction to Differential Equations
MTH 417 Survey of Multivariable Calculus
MTH 418 Survey of Partial Differential Equations
PHY 107 General Physics I or PHY117 Honors Physics I
PHY 108 General Physics II or PHY118 Honors Physics II
PHY 158 General Physics II Lab
PHY 207 General Physics III or PHY217 Honors Physics III
PHY 208 General Physics IV
PHY 257 General Physics III Lab
PHY 301 Intermediate Mechanics I
PHY 302 Intermediate Mechanics II
PHY 307 Modern Physics Lab
PHY 401 Quantum Mechanics I-fundamentals
PHY 402 Quantum Mechanics II-applications
PHY 403 Electricity and Magnetism I
PHY 404 Electricity and Magnetism II
PHY 405 Thermal and Statistical Physics I
PHY 407 Advanced Laboratory or PHY 408 Advanced Laboratory

One additional 3-credit technical elective course in physics, another science, engineering, or mathematics at or above the 300-level, as approved by the Physics Undergraduate Director.
### RECOMMENDED SEQUENCE FOR BS IN PHYSICS MAJOR REQUIREMENTS

#### First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 101 General Chemistry</td>
<td>CHE 102 General Chemistry</td>
</tr>
<tr>
<td>MTH 141 College Calculus I</td>
<td>MTH 142 College Calculus II</td>
</tr>
<tr>
<td>PHY 107 General Physics I or</td>
<td>PHY 108 General Physics II or</td>
</tr>
<tr>
<td>PHY 117 Honors Physics I (preferred)</td>
<td>PHY 118 Honors Physics II (preferred)</td>
</tr>
<tr>
<td>ENG 101 (or 201*)</td>
<td>PHY 158 General Physics II Lab</td>
</tr>
<tr>
<td>Library Skills</td>
<td>ENG 201 (or Humanities Gen Ed*)</td>
</tr>
</tbody>
</table>

#### Second Year

<p>| | |</p>
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<tr>
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<tbody>
<tr>
<td>MTH 241 College Calculus III</td>
<td>PHY 207 General Physics III or</td>
</tr>
<tr>
<td></td>
<td>PHY 217 Honors Physics III</td>
</tr>
<tr>
<td>MTH 306 Intro to Differential Equations</td>
<td>PHY 257 General Physics III Lab</td>
</tr>
<tr>
<td>PHY 208 General Physics IV</td>
<td>MTH 418 Survey of Partial Differential Eqns</td>
</tr>
<tr>
<td>UGC 111</td>
<td>UGC 112</td>
</tr>
<tr>
<td>Language 1</td>
<td>Language 2</td>
</tr>
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</table>

#### Third Year

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>PHY 301 Intermediate Mechanics I</td>
<td>PHY 302 Intermediate Mechanics II</td>
</tr>
<tr>
<td>PHY 401 Quantum Mechanics I</td>
<td>PHY 307 Modern Physics Lab</td>
</tr>
<tr>
<td>MTH 417 Survey of Multivariable Calculus</td>
<td>PHY 402 Quantum Mechanics II</td>
</tr>
<tr>
<td>UGC 211 (or American Pluralism)</td>
<td>Arts Gen Ed</td>
</tr>
</tbody>
</table>
<pre><code>                                                                         | Social Science                                |
</code></pre>

#### Fourth Year

<p>| | |</p>
<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>PHY 403 Electricity and Magnetism I</td>
<td>PHY 404 Electricity and Magnetism II</td>
</tr>
<tr>
<td>PHY 405 Thermal and Statistical Physics I</td>
<td>PHY Elective</td>
</tr>
<tr>
<td>PHY elective</td>
<td>Technical elective (F or Sp)</td>
</tr>
<tr>
<td>PHY 407 Advanced Laboratory (F) or PHY 408 Advanced Laboratory (Sp)</td>
<td></td>
</tr>
</tbody>
</table>

*Students placed into ENG 101 should take ENG 101 in the fall and ENG 201 in the spring. Students placed in ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed in the spring.*
**SUMMARY of Credit Hours**

<table>
<thead>
<tr>
<th>Category</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total required credit hours in physics</td>
<td>52</td>
</tr>
<tr>
<td>Total required credit hours outside physics</td>
<td>34</td>
</tr>
<tr>
<td>General education courses and electives</td>
<td>34</td>
</tr>
<tr>
<td>Total required credit hours</td>
<td>120</td>
</tr>
</tbody>
</table>
PHYSICS–B.A.

Acceptance Criteria: GPA of 2.0 in MTH 141–142, PHY 107–108/158

REQUIRED COURSES
CHE 101 General Chemistry
CHE 102 General Chemistry
MTH 141 College Calculus I
MTH 142 College Calculus II
MTH 241 College Calculus III
MTH 306 Introduction to Differential Equations
PHY 107 General Physics I or PHY 117 Honors Physics I
PHY 108 General Physics II or PHY 118 Honors Physics II
PHY 158 General Physics II Lab
PHY 207 General Physics III or PHY 217 Honors Physics III
PHY 208 General Physics IV
PHY 257 General Physics III Lab
PHY 301 Intermediate Mechanics I
PHY 307 Modern Physics Lab
PHY 401 Quantum Mechanics I-fundamentals
PHY 402 Quantum Mechanics II-applications
PHY 403 Electricity and Magnetism I
PHY 405 Thermal and Statistical Physics I
PHY 407 Advanced Laboratory or PHY 408 Advanced Laboratory


One additional 300/400-level PHY course excluding PHY 499

RECOMMENDED SEQUENCE FOR BA IN PHYSICS MAJOR REQUIREMENTS

<p>| First Year |
|-----------|-------------|
| <strong>Fall</strong>  | <strong>Spring</strong>  |
| CHE 101 General Chemistry | CHE 102 General Chemistry |
| MTH 141 College Calculus I | MTH 142 College Calculus II |
| PHY 107 General Physics I or PHY 117 Honors Physics I (preferred) | PHY 108 General Physics II or PHY 118 Honors Physics II (preferred) |
| ENG 101 or ENG 201* | PHY 158 General Physics II Lab |
| Library Skills | ENG 201 or Humanities* |</p>
<table>
<thead>
<tr>
<th>Second Year</th>
<th>Third Year</th>
<th>Fourth Year</th>
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</thead>
<tbody>
<tr>
<td>MTH 241 College Calculus III</td>
<td>PHY 207 General Physics III or</td>
<td>PHY 403 Electricity and Magnetism I</td>
</tr>
<tr>
<td></td>
<td>PHY 217 Honors Physics III</td>
<td>PHY 405 Thermal and Statistical Physics I</td>
</tr>
<tr>
<td>PHY 208 General Physics IV</td>
<td>PHY 257 General Physics III Lab</td>
<td>PHY 407 Advanced Laboratory (F) or</td>
</tr>
<tr>
<td>UGC 111</td>
<td>UGC 112</td>
<td>PHY 408 Advanced Laboratory (Sp)</td>
</tr>
</tbody>
</table>
| Language 1                          |                                     | Arts Gen Ed                           | *

*Students placed into ENG 101 should take ENG 101 in the fall and ENG 201 in the spring. Students placed into ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed in the spring.

**SUMMARY of Credit Hours**

<p>| | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Total required credit hours in physics</td>
<td>46</td>
</tr>
<tr>
<td>Total required credit hours outside physics</td>
<td>26</td>
</tr>
<tr>
<td>General education courses and electives</td>
<td>48</td>
</tr>
<tr>
<td>Total required credit hours</td>
<td>120</td>
</tr>
</tbody>
</table>
PHYSICS - MINOR

Acceptance Criteria:  GPA of 2.0 in MTH 141–142, PHY 107–108/158

REQUIRED COURSES
MTH 141 College Calculus I
MTH 142 College Calculus II
PHY 107 General Physics I or PHY 117 Honors Physics I
PHY 108 General Physics II or PHY 118 Honors Physics II
PHY 158 General Physics II Lab
PHY 207 General Physics III or PHY 217 Honors Physics III (lab is not required)
PHY 208 General Physics IV (lab is not required)
PHY 301 Intermediate Mechanics I
PHY 403 Electricity and Magnetism I

One 300/400-level PHY elective course (excluding PHY 499; PHY 401 Quantum Mechanics I - Fundamentals is strongly recommended)

RECOMMENDED SEQUENCE FOR MINOR REQUIREMENTS

<table>
<thead>
<tr>
<th>First Year</th>
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</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td>MTH 141 College Calculus I</td>
<td>MTH 142 College Calculus II</td>
<td></td>
</tr>
<tr>
<td>PHY 107 General Physics I or PHY 117 Honors Physics I</td>
<td>PHY 108 General Physics II or PHY 118 Honors Physics II</td>
<td></td>
</tr>
<tr>
<td>PHY 158 General Physics II Lab</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Second Year</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>PHY 208 General Physics IV</td>
<td>PHY 207 General Physics III or PHY 217 Honors Physics III</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Third Year</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 301 Intermediate Mechanics I</td>
<td></td>
</tr>
<tr>
<td>PHY Elective</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Fourth Year</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 403 Electricity and Magnetism I</td>
<td></td>
</tr>
</tbody>
</table>

SUMMARY of Credit Hours

- Total required credit hours in physics: 25
- Total required credit hours outside physics: 8
- Total required credit hours: 33
PHYSICS – B.A. WITH TEACHING OF SCIENCE CONCENTRATIONS

Students pursuing this concentration must also pursue the Undergraduate Minor in Education, which is administered by the Department of Learning and Instruction (LAI). Applications to the minor must be filed with the LAI office in 505 Baldy Hall (the application is available online at http://gse.buffalo.edu/programs/edminor).

This concentration is designed for the student whose career goal is to teach physics (or physics and chemistry, see below) in grades 7-12. Students interested in this concentration should obtain advisement from the director of undergraduate studies in physics and, for questions related to the education courses, from the LAI office.

Completion of the major concentration (including the required education courses) provides a strong foundation in content knowledge and a head start on education coursework required for an Initial Teacher Certificate to begin teaching in grades 7-12 in New York. In order to receive a University at Buffalo recommendation for the issuance of the Initial Teacher Certificate, a student must successfully complete the graduate-level initial teacher education program within the Graduate School of Education (http://gse.buffalo.edu/). It is then possible to complete, within the state-mandated five years, the master’s degree required for a Professional Teacher Certificate, provided all New York State requirements have been successfully completed.

Acceptance Criteria for Physics: GPA of 2.0 in MTH 141–142, PHY 107–108/158. LAI requires a minimum overall GPA of 2.5 for admission to the minor in education.

TEACHING OF SCIENCE – PHYSICS

REQUIRED COURSES FOR PHYSICS
CHE 101 General Chemistry
CHE 102 General Chemistry
MTH 141 College Calculus I
MTH 142 College Calculus II
MTH 241 College Calculus III
MTH 306 Introduction to Differential Equations
PHY 107 General Physics I or PHY 117 Honors Physics I
PHY 108 General Physics II or PHY 118 Honors Physics II
PHY 158 General Physics II Lab
PHY 207 General Physics III or PHY 217 Honors Physics III
PHY 208 General Physics IV
PHY 257 General Physics III Lab
PHY 307 Modern Physics Lab
Four 300/400-level PHY electives (excluding PHY 499)
## RECOMMENDED SEQUENCE FOR TEACHING OF SCIENCE MAJOR REQUIREMENTS

### Teaching of Science – Physics

#### First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>CHE 101 General Chemistry</td>
<td>CHE 102 General Chemistry</td>
</tr>
<tr>
<td>MTH 141 College Calculus I</td>
<td>MTH 142 College Calculus II</td>
</tr>
<tr>
<td>PHY 107 General Physics I or PHY 117 Honors Physics I (preferred)</td>
<td>PHY 108 General Physics II or PHY 118 Honors Physics II</td>
</tr>
<tr>
<td>ENG 101 or 201*</td>
<td>PHY 158 General Physics II Lab</td>
</tr>
<tr>
<td></td>
<td>ENG 201 or Humanities Gen Ed*</td>
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</tbody>
</table>

#### Second Year

<table>
<thead>
<tr>
<th>MTH 241 College Calculus III</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTH 306 Intro to Differential Equations</td>
</tr>
<tr>
<td>PHY 208 General Physics IV</td>
</tr>
<tr>
<td>UGC 111</td>
</tr>
<tr>
<td>Language 1</td>
</tr>
</tbody>
</table>

#### Third Year

| PHY Elective                                                      | PHY 307 Modern Physics Lab                           |
| UGC 211 or American Pluralism                                     | PHY Elective                                         |
| Arts Gen Ed                                                       | Social Science                                       |

#### Fourth Year

| PHY Elective                                                      | PHY Elective                                         |

*Students placed into ENG 101 should take ENG 101 in the fall and ENG 201 in the spring. Students placed into ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed in the spring.

### SUMMARY of Credit Hours

- Total required credit hours in mathematics, chemistry and physics: 57
- Total required credit hours in education: 19
- General education courses and electives: 44
- Total required credit hours: 120
TEACHING OF SCIENCE – PHYSICS AND CHEMISTRY

REQUIRED COURSES
CHE 101 General Chemistry
CHE 102 General Chemistry
CHE 201 Organic Chemistry
CHE 202 Organic Chemistry
CHE 214 Introduction to Analytical Chemistry
MTH 141 College Calculus I
MTH 142 College Calculus II
MTH 241 College Calculus III
MTH 306 Introduction to Differential Equations
PHY 107 General Physics I or PHY 117 Honors Physics I
PHY 108 General Physics II or PHY 118 Honors Physics II
PHY 158 General Physics II Lab
PHY 207 General Physics III or PHY 217 Honors Physics III
PHY 208 General Physics IV
PHY 257 General Physics III Lab
PHY 307 Modern Physics Lab
Two 300/400-level PHY electives (excluding PHY 499)

RECOMMENDED SEQUENCE FOR TEACHING OF SCIENCE MAJOR REQUIREMENTS

Provisional Certification in Physics and Chemistry

<table>
<thead>
<tr>
<th>First Year</th>
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<tbody>
<tr>
<td><strong>Fall</strong></td>
<td><strong>Spring</strong></td>
</tr>
<tr>
<td>CHE 101 General Chemistry</td>
<td>CHE 102 General Chemistry</td>
</tr>
<tr>
<td>MTH 141 College Calculus I</td>
<td>MTH 142 College Calculus II</td>
</tr>
<tr>
<td>PHY 107 General Physics I or PHY 117 Honors Physics I (preferred)</td>
<td>PHY 108 General Physics II or PHY 118 Honors Physics II (preferred)</td>
</tr>
<tr>
<td>ENG 101 or 201*</td>
<td>PHY 158 General Physics II Lab</td>
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<tr>
<td>ENG 201 or Humanities Gen Ed</td>
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<th>Second Year</th>
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<tbody>
<tr>
<td>MTH 241 College Calculus III</td>
<td>PHY 207 General Physics III or PHY 217 Honors Physics III</td>
</tr>
<tr>
<td>MTH 306 Intro to Differential Equations</td>
<td>PHY 257 General Physics III Lab</td>
</tr>
<tr>
<td>PHY 208 General Physics IV</td>
<td>UGC 112</td>
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Third Year

<table>
<thead>
<tr>
<th>CHE 201 Organic Chemistry</th>
<th>CHE 202 Organic Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 214 Introduction to Analytical Chemistry</td>
<td>PHY 307 Modern Physics Lab</td>
</tr>
<tr>
<td>UGC 211 or American Pluralism</td>
<td>Arts Gen Ed</td>
</tr>
<tr>
<td></td>
<td>Social Science</td>
</tr>
</tbody>
</table>

Fourth Year

| PHY Elective | PHY Elective |

*Students placed into ENG 101 should take ENG 101 in the fall and ENG 201 in the spring. Students placed into ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed in the spring.*

**SUMMARY of Credit Hours**

- Total required credit hours in chemistry, mathematics, and physics: 61
- Total required credit hours in education: 19
- General education courses and electives: 37
- Total required credit hours: 120
# MATHEMATICAL PHYSICS – B.S.

**Acceptance Criteria:** GPA of 2.5 in MTH 141–142, PHY 107–108/158.

**REQUIRED COURSES**
- MTH 141 College Calculus I
- MTH 142 College Calculus II
- MTH 241 College Calculus III
- MTH 306 Introduction to Differential Equations
- MTH 309 Introductory Linear Algebra
- MTH 417 Survey of Multivariable Calculus
- MTH 418 Survey of Partial Differential Equations
- MTH 419 Introduction to Abstract Algebra or MTH 420 Advanced Linear Algebra
- MTH 425 Introduction to Complex Variables I
- One 300/400-level MTH elective
- PHY 107 General Physics I or PHY 117 Honors Physics I
- PHY 108 General Physics II or PHY 118 Honors Physics II
- PHY 158 General Physics II Lab
- PHY 207 General Physics III or PHY 217 Honors Physics III
- PHY 208 General Physics IV
- PHY 257 General Physics III Lab
- PHY 301 Intermediate Mechanics I
- PHY 307 Modern Physics Lab
- PHY 401 Quantum Mechanics I-fundamentals
- PHY 403 Electricity and Magnetism I
- PHY 405 Thermal and Statistical Physics I
- PHY 407 or PHY 408 Advanced Laboratory
- PHY 431 Introduction to Mathematical Physics I
- One PHY elective (one of the following: PHY 302 Intermediate Mechanics II, PHY 402 Quantum Mechanics II, PHY 404 Electricity and Magnetism II, or PHY 406 Thermal and Statistical Physics II)

**RECOMMENDED SEQUENCE FOR BS IN MATHEMATICAL PHYSICS MAJOR REQUIREMENTS**

<table>
<thead>
<tr>
<th>First Year</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTH 141 College Calculus I</td>
<td>MTH 142 College Calculus II</td>
<td></td>
</tr>
<tr>
<td>PHY 107 General Physics I or PHY 117 Honors Physics I (preferred)</td>
<td>PHY 108 General Physics II or PHY 118 Honors Physics II (preferred)</td>
<td></td>
</tr>
<tr>
<td>ENG 101 or 201*</td>
<td>PHY 158 General Physics II Lab</td>
<td></td>
</tr>
<tr>
<td>Arts Gen Ed</td>
<td>ENG 201 or Humanities*</td>
<td></td>
</tr>
<tr>
<td>Library Skills</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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* Arts Gen Ed courses must be completed with a grade of C or better.
### Second Year

<table>
<thead>
<tr>
<th>MTH 241 College Calculus III</th>
<th>MTH 309 Introductory Linear Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTH 306 Introduction to Differential Equations</td>
<td>PHY 207 General Physics III or PHY 217 Honors Physics III</td>
</tr>
<tr>
<td>PHY 208 General Physics IV</td>
<td>PHY 257 General Physics III Lab</td>
</tr>
<tr>
<td>UGC 111</td>
<td>UGC 112</td>
</tr>
<tr>
<td>Language 1</td>
<td>Language 2</td>
</tr>
</tbody>
</table>

### Third Year

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 301 Intermediate Mechanics I</td>
<td>PHY Elective (if not taken in 4th year)</td>
</tr>
<tr>
<td>PHY 401 Quantum Mechanics I</td>
<td>PHY 307 Modern Physics Lab</td>
</tr>
<tr>
<td>UGC 211 or American Pluralism</td>
<td>Social Science</td>
</tr>
</tbody>
</table>

### Fourth Year

<table>
<thead>
<tr>
<th>MTH 419 Introduction to Abstract Algebra</th>
<th>MTH 425 Introduction to Complex Variables I</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 431 Intro. To Math. Physics I</td>
<td>MTH Elective</td>
</tr>
<tr>
<td>PHY 403 Electricity and Magnetism I</td>
<td>PHY 408 Advanced Laboratory</td>
</tr>
<tr>
<td>PHY 405 Thermal and Statistical Physics I</td>
<td>PHY Elective (if not taken in 3rd year)</td>
</tr>
</tbody>
</table>

* Students placed into ENG 101 should take ENG 101 in the fall semester and ENG 201 in the spring semester. Students placed into ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed course in the spring.

### SUMMARY of Credit Hours

- Total required credit hours in mathematics and physics: 79
- General education courses and electives: 41
- Total required credit hours: 120
ENGINEERING PHYSICS-B.S.

Acceptance Criteria: In order to be considered for admission, a grade of C or better must be obtained in all technical courses. Students receiving a grade of D or F in any technical course during the first two semesters must repeat the course and receive a grade of C or better to be considered for the program. The technical courses that are required in the first two semesters are: MTH 141-142, PHY 107 (or PHY 117), CHE 107-108, and EAS 140. Application for this program should be made through the School of Engineering and Applied Sciences in 410 Bonner Hall (See Sec. VI). Interested students should meet an advisor in the School of Engineering and Applied Sciences, 410 Bonner Hall. The Chair of this joint major program is Prof. S. Batalama, 230 Davis Hall, 716-645-1147, batalama@buffalo.edu.

REQUIRED COURSES

CHE 107 General Chemistry for Engineers
CHE 108 General Chemistry for Engineers
EAS 140 Engineering Solutions
EAS 202 Engineering Impact On Society
EAS 230 Higher-Level Language
EE 202 Circuit Analysis I
EE 310 Electronic Devices and Circuits I
EE 311 Electronic Devices and Circuits II
EE 352 Introduction to Electronics Lab
EE 353 Electronic Circuits Lab
EE 410 Electronic Instrument Design I
MAE 335 Fluid Mechanics
MTH 141 College Calculus I
MTH 142 College Calculus II
MTH 241 College Calculus III
MTH 306 Introduction to Differential Equations
MTH 417 Survey of Multivariable Calculus
MTH 418 Survey of Partial Differential Equations
PHY 107 General Physics I or PHY 117 Honors Physics I
PHY 108 General Physics II or PHY 118 Honors Physics II
PHY 158 General Physics II Lab
PHY 207 General Physics III or PHY 217 Honors Physics III
PHY 208 General Physics IV
PHY 257 General Physics III Lab
PHY 301 Intermediate Mechanics I
PHY 307 Modern Physics Lab
PHY 401 Modern Physics I
PHY 402 Modern Physics II
PHY 403 Electricity and Magnetism I
PHY 404 Electricity and Magnetism II
PHY 405 Thermal and Statistical Physics I
PHY 407 Advanced Laboratory or PHY 408 Advanced Laboratory
Three technical electives
## RECOMMENDED SEQUENCE FOR BS IN ENGINEERING PHYSICS MAJOR REQUIREMENTS

### First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 107 General Chemistry for Engineers</td>
<td>CHE 108 General Chemistry for Engineers</td>
</tr>
<tr>
<td>EAS 140 Engineering Solutions</td>
<td>MTH 142 College Calculus II</td>
</tr>
<tr>
<td>MTH 141 College Calculus I</td>
<td>PHY 108 General Physics II or</td>
</tr>
<tr>
<td></td>
<td>PHY 118 Honors Physics II (preferred)</td>
</tr>
<tr>
<td>PHY 107 General Physics I or</td>
<td>PHY 158 General Physics II Lab</td>
</tr>
<tr>
<td>PHY 117 Honors Physics I (preferred)</td>
<td>EAS 202</td>
</tr>
<tr>
<td>Gen Ed*</td>
<td>Gen Ed*</td>
</tr>
</tbody>
</table>

### Second Year

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>EE 202 Circuit Analysis I</td>
<td>EAS 230 Higher-Level Language</td>
</tr>
<tr>
<td>MTH 241 College Calculus III</td>
<td>PHY 207 General Physics III or</td>
</tr>
<tr>
<td></td>
<td>PHY 217 Honors Physics III</td>
</tr>
<tr>
<td>MTH 306 Introduction to</td>
<td>PHY 257 General Physics III Lab</td>
</tr>
<tr>
<td>Differential Eqns.</td>
<td></td>
</tr>
<tr>
<td>PHY 208 General Physics IV</td>
<td>MTH 418 Survey of Partial Differential Eqns.</td>
</tr>
<tr>
<td>Gen Ed*</td>
<td>Technical Elective</td>
</tr>
</tbody>
</table>

### Third Year

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EE 310 Electronic Devices and</td>
<td>EE 311 Electronic Devices and Circuits II</td>
</tr>
<tr>
<td>Circuits I</td>
<td></td>
</tr>
<tr>
<td>EE 352 Introduction to</td>
<td>EE 353 Electronic Circuits Lab</td>
</tr>
<tr>
<td>Electronics Lab</td>
<td></td>
</tr>
<tr>
<td>PHY 301 Intermediate</td>
<td>two Gen Eds*</td>
</tr>
<tr>
<td>Mechanics I</td>
<td></td>
</tr>
<tr>
<td>PHY 401 Modern Physics I</td>
<td>PHY 307 Modern Physics Lab</td>
</tr>
<tr>
<td>MTH 417 Survey of Multivariable Calculus</td>
<td>PHY 402 Modern Physics II</td>
</tr>
</tbody>
</table>

### Fourth Year

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EE 410 Electronic Instrument</td>
<td>Gen Ed*</td>
</tr>
<tr>
<td>Design I</td>
<td></td>
</tr>
<tr>
<td>MAE 335 Fluid Mechanics</td>
<td>PHY 404 Electricity and Magnetism II</td>
</tr>
<tr>
<td>PHY 403 Electricity and</td>
<td>Technical Elective</td>
</tr>
<tr>
<td>Magnetism I</td>
<td></td>
</tr>
<tr>
<td>PHY 405 Thermal and</td>
<td>Technical Elective</td>
</tr>
<tr>
<td>Statistical Physics I</td>
<td></td>
</tr>
<tr>
<td>Gen Ed*</td>
<td>PHY408 Advanced Laboratory</td>
</tr>
</tbody>
</table>

*See the School of Engineering and Applied Sciences academic requirements section in the UB catalogue.

### TECHNICAL ELECTIVES

Technical electives can be chosen from among the approved list of the possible required elective courses, or approved technical electives for either the B.S. in physics or the B.S. in electrical engineering program. At
least one technical elective must be chosen from the electrical engineering list. Recommended technical electives appropriate to this program are: EE 489, EE 490, PHY 425 Intermediate Optics, PHY 434 Solid State Physics, PHY 406 Thermal and Statistical Physics II, PHY 407 or PHY 408 Advanced Laboratory.

**SUMMARY of Credit Hours**

<table>
<thead>
<tr>
<th>Description</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total required credit hours in math, physics, chemistry and engineering</td>
<td>111</td>
</tr>
<tr>
<td>Total required credit hours</td>
<td>129</td>
</tr>
</tbody>
</table>
COMPUTATIONAL PHYSICS – B.S.

Acceptance Criteria: GPA of 2.5 in CSE 115-116, MTH 141-142, PHY 107-108/158.

REQUIRED COURSES
CSE 115 Introduction to Computer Science for Majors I
CSE 116 Introduction to Computer Science for Majors II
CSE/MTH 191 Introduction to Discrete Mathematics
CSE 250 Algorithms and Data Structures
CSE 305 Introduction to Programming Languages
CSE/MTH 437 Introduction to Numerical Analysis I or PHY 410 Computational Physics I
CSE/MTH 438 Introduction to Numerical Analysis II or PHY 411 Computational Physics II
CSE 442 Software Engineering
MTH 141 College Calculus I
MTH 142 College Calculus II
MTH 241 College Calculus III
MTH 306 Introduction to Differential Equations
MTH 309 Introductory Linear Algebra
PHY 107 General Physics I or PHY 117 Honors Physics I
PHY 108 General Physics II or PHY 118 Honors Physics II
PHY 158 General Physics II Lab
PHY 207 General Physics III or PHY 217 Honors Physics III
PHY 208 General Physics IV
PHY 257 General Physics III Lab
PHY 301 Intermediate Mechanics I
PHY 307 Modern Physics Lab
PHY 401 Quantum Mechanics I-fundamentals
PHY 403 Electricity and Magnetism I
PHY 405 Thermal and Statistical Physics I
PHY 407 Advanced Laboratory or PHY 408 Advanced Laboratory
One elective (Choose a calculus-based probability/statistics course, e.g., EAS 305 Applied Probability or MTH 411 Probability Theory)

RECOMMENDED SEQUENCE FOR BS IN COMPUTATIONAL PHYSICS MAJOR
REQUIREMENTS

<table>
<thead>
<tr>
<th>First Year</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>CSE 115 Introduction to Computer Science for Majors I</td>
<td>CSE 116 Introduction to Computer Science for Majors II</td>
</tr>
<tr>
<td>March</td>
<td>MTH 141 College Calculus I</td>
<td>MTH 142 College Calculus II</td>
</tr>
</tbody>
</table>
PHY 107 General Physics I or
PHY 117 Honors Physics I (preferred)  
PHY 108 General Physics II or
PHY 118 Honors Physics II (preferred)  
ENG 101 or 201*  
Library Skills  
PHY 158 General Physics II Lab  
ENG 201 or Humanities*

<table>
<thead>
<tr>
<th>Second Year</th>
</tr>
</thead>
</table>
| CSE/MTH 191 Introduction to Discrete Mathematics  
CSE 250 Algorithms and Data Structures |
| MTH 241 College Calculus III  
PHY 207 General Physics III or
PHY 217 Honors Physics III (if offered) |
| MTH 306 Intro to Differential Equations  
PHY 257 General Physics III Lab |
| PHY 208 General Physics IV  
UGC 112 |
| UGC 111  
Social Science |

<table>
<thead>
<tr>
<th>Third Year</th>
</tr>
</thead>
</table>
| PHY 301 Intermediate Mechanics I  
MTH 309 Introductory Linear Algebra |
| PHY 401 Quantum Mechanics I  
PHY 307 Modern Physics Lab |
| Elective (Calculus-based prob/stat course)  
CSE 305 Intro to Programming Languages |
| CSE 442 Software Engineering  
UGC 211 or American Pluralism |
| Language 1  
Language 2 |

<table>
<thead>
<tr>
<th>Fourth Year</th>
</tr>
</thead>
</table>
| PHY 403 Electricity and Magnetism I  
CSE/MTH 438 Introduction to Numerical Analysis II or
PHY 411 Computational Physics II |
| PHY 405 Thermal and Statistical Physics I  
PHY 407(F) or 408(Sp) Advanced Laboratory |
| CSE/MTH 437 Introduction to Numerical Analysis I or PHY 410 Computational Physics I  
Arts Gen Ed |

*Students placed into ENG 101 should take ENG 101 in the fall and ENG 201 in the spring. Students placed in ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed in the spring.

**SUMMARY of Credit Hours**

- Total required credit hours in computer science, mathematics, and physics: 87-90
- General education courses and electives: 33-30
- Total required credit hours: 120
5 YEAR BS IN COMPUTATIONAL PHYSICS/MS IN PHYSICS


REQUIRED COURSES
CSE 115 Introduction to Computer Science for Majors I
CSE 116 Introduction to Computer Science for Majors II
CSE/MTH 191 Introduction to Discrete Mathematics
CSE 250 Algorithms and Data Structures
CSE 305 Introduction to Programming Languages
CSE 442 Software Engineering
MTH 141 College Calculus I
MTH 142 College Calculus II
MTH 241 College Calculus III
MTH 306 Introduction to Differential Equations
MTH 309 Introductory Linear Algebra
PHY 107 General Physics I or PHY 117 Honors Physics I
PHY 108 General Physics II or PHY 118 Honors Physics II
PHY 158 General Physics II Lab
PHY 207 General Physics III or PHY 217 Honors Physics III
PHY 208 General Physics IV
PHY 257 General Physics III Lab
PHY 301 Intermediate Mechanics I
PHY 307 Modern Physics Lab
PHY 401 Quantum Mechanics I-fundamentals
PHY 403 Electricity and Magnetism I
PHY 405 Thermal and Statistical Physics I
Elective (Calculus-based probability/statistics course, e.g., EAS 305 Applied Probability or MTH 411 Probability Theory)
PHY 505 Computational Physics I
PHY 506 Computational Physics II
PHY 515 High Performance Scientific Computing I
PHY 516 High Performance Scientific Computing II
PHY 551 or PHY 552 Graduate Lab
15 Credits of PHY 500 (electives and M.S. thesis)
## RECOMMENDED SEQUENCE OF BS IN COMPUTATIONAL PHYSICS/MS IN PHYSICS MAJOR REQUIREMENTS

### First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE 115 Introduction to Computer Science for Majors I</td>
<td>CSE 116 Introduction to Computer Science for Majors II</td>
</tr>
<tr>
<td>MTH 141 College Calculus I</td>
<td>MTH 142 College Calculus II</td>
</tr>
<tr>
<td>PHY 107 General Physics I or PHY 117 Honors Physics I (preferred)</td>
<td>PHY 108 General Physics II or PHY 118 Honors Physics II (preferred)</td>
</tr>
<tr>
<td>ENG 101 or 201*</td>
<td>ENG 201 or Humanities Gen Ed*</td>
</tr>
</tbody>
</table>

### Second Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE/MTH 191 Introduction to Discrete Mathematics</td>
<td>CSE 250 Algorithms and Data Structures</td>
</tr>
<tr>
<td>MTH 241 College Calculus III</td>
<td>PHY 207 General Physics III or PHY 217 Honors Physics III (if offered)</td>
</tr>
<tr>
<td>MTH 306 Intro to Differential Equations</td>
<td>PHY 257 General Physics III Lab</td>
</tr>
<tr>
<td>PHY 208 General Physics IV</td>
<td>UGC 112</td>
</tr>
<tr>
<td>UGC 111</td>
<td>Social Science</td>
</tr>
</tbody>
</table>

### Third Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 301 Intermediate Mechanics I</td>
<td>MTH 309 Introductory Linear Algebra</td>
</tr>
<tr>
<td>PHY 401 Modern Physics I</td>
<td>PHY 307 Modern Physics Lab</td>
</tr>
<tr>
<td>Elective (Calculus-based probability/statistics course)</td>
<td>CSE 305 Intro to Programming Languages</td>
</tr>
<tr>
<td>UGC 211 or American Pluralism</td>
<td>Language 2</td>
</tr>
<tr>
<td>Language 1</td>
<td></td>
</tr>
</tbody>
</table>

### Fourth Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSE 442 Software Engineering</td>
<td>PHY 506 Computational Physics II</td>
</tr>
<tr>
<td>PHY 403 Electricity and Magnetism I</td>
<td>PHY 551(F) or PHY 552 (Sp) Graduate Lab</td>
</tr>
<tr>
<td>PHY 405 Thermal and Statistical Physics I</td>
<td>PHY 500-level Elective and M.S. Thesis</td>
</tr>
<tr>
<td>PHY 505 Computational Physics I</td>
<td></td>
</tr>
<tr>
<td>Arts Gen Ed</td>
<td></td>
</tr>
</tbody>
</table>

### Fifth Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 515 High Performance Scientific Computing I</td>
<td>PHY 516 High Performance Scientific Computing II</td>
</tr>
<tr>
<td>PHY 500-level Elective and M.S. Thesis</td>
<td>PHY 500-level Elective and M.S. Thesis</td>
</tr>
</tbody>
</table>
*Students placed into ENG 101 should take ENG 101 in the fall and ENG 201 in the spring. Students placed into ENG 201 should take ENG 201 in the fall and a Humanities Gen Ed in the spring.

**SUMMARY of Credit Hours**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total required Undergraduate credit hours in:</td>
<td></td>
</tr>
<tr>
<td>computer science, mathematics, and physics</td>
<td>78</td>
</tr>
<tr>
<td>General education courses and electives</td>
<td>32</td>
</tr>
<tr>
<td>Graduate credit hours</td>
<td>30</td>
</tr>
<tr>
<td>Total required credit hours</td>
<td>140</td>
</tr>
</tbody>
</table>
IV. GENERAL EDUCATION REQUIREMENTS

A student’s requirements are determined by the academic year of entry to U.B. For details, see the Archived Catalogs at http://undergrad-catalog.buffalo.edu. Questions on your Gen-Ed requirements should be directed to the CAS Office of Student Advisement Services at http://casadvising.buffalo.edu.

For All Students Who Enter Fall 2013 and Spring 2014, the Gen. Ed. Requirements as listed at http://undergrad-catalog.buffalo.edu/policies/degree/gened.shtml are:

Writing

Complete ENG 101 and ENG 201, as placed, unless exempted.

Library Skills

Complete the Library Skills Workbook within the first year of study at UB.

Mathematical Sciences

Complete one course from the following lists.

Recommended Courses for Students Who are Not Meeting a Specific Requirement of a Major

- CSE 111 Great Ideas in Computer Science I
- STA 119 Introduction to Statistics

Additional Courses that Satisfy the Mathematical Sciences Requirement

- CEP 207 or GEO 410 or MGQ 301 or PSC 408 or PSY 207 or SOC 294 or SOC 404 or SSC 225 or STA 111 - STA 112*
- CSE 113 Introduction to Computer Science I
- CSE 115 Introduction to Computer Science for Majors I
- CSE 116 Introduction to Computer Science for Majors II
- CSE 191 Introduction to Discrete Structures
- MTH 115 or ULC 148 Survey of Algebra and Trigonometry
• MTH 121 or MTH 131 or MTH 141 or MTH 153*
• MTH 122 or MTH 142 or MTH 154*
• MTH 181 Conceptual Mathematics I
• PHI 315 Symbolic Logic
• PHI 415 Logical Theory I
• PHI 416 Logical Theory II

*Courses grouped together are equivalent courses. Students should not take more than one course from each group.

World Civilizations

Complete UGC 111 and UGC 112 World Civilizations I-II. (**See note at end of this section.)

Natural Sciences

Students must complete a two-course sequence, including at least one semester of laboratory. Allowable two-course sequences are outlined in lists below.

Recommended Course Sequences for Students Who Are Not Meeting a Specific Requirement of a Major

• BIO 129 - BIO 130 Perspectives in Human Biology
• GEO 101 and GEO 106 Physical Environmental Geography
• GLY 101 - GLY 102 Global Environmental Science
• NTR 108 - NTR 109/NTR 110 Human Nutrition/Nutrition in Practice
• PHY 121 - PHY 122 Descriptive Astronomy

Additional Course Sequences that Satisfy the Natural Sciences Requirement

• BIO 200 Evolutionary Biology and BIO 201 Cell Biology
• BIO 200 Evolutional Biology and BIO 309 Ecology
• CHE 101 - CHE 102 General Chemistry
• CHE 105 - CHE 106 Chemistry: Principles and Applications
• CHE 107 - CHE 108 General Chemistry for Engineers
• GLY 103 - GLY 104 Evolution of the Earth and Solar System
• PHY 101/PHY 151 - PHY 102/PHY 152 College Physics I-II/Lab
• PHY 107 - PHY 108/PHY 158 General Physics I-II/Lab
• PHY 117 - PHY 118/PHY 158 Honors Physics I-II/Lab

Note: School of Architecture majors only may complete ARC 352 and PHY 101; Nursing majors only may complete ANA 113 and PGY 300. School of Public Health and Health Profession majors only may complete ES 207 and PGY 300.

American Pluralism or Cognate (approved equivalent courses)

Complete UGC 211 American Pluralism and the Search for Equality or any one of the following: AAS 261, ARC 211, AHI 390, DMS 213, GEO 231, HIS 161, HIS 162, LIN 200, SOC 211, TH 220. (**See note at end of this section.)

Note: UGC 111 - UGC 112 World Civilizations I-II should be completed first.

Social and Behavioral Sciences

Complete one 3-credit course offered by APY, CDS, COM, ECO, GEO, LIN, PSC, PSY, SSC, or SOC; or ARC 122, PD 120, PD 212.

Note: Courses used to satisfy any other general education requirement are excluded.

Language Requirement

NOTE: See the Foreign Language Placement section of the catalog for appropriate placement level.

For native speakers of English, students must demonstrate elementary-level proficiency in a language other than English by doing one of the following:

• Completing a 2-semester first-year sequence of college-level courses in a language other than English (e.g. Spanish 101-102, Modern Greek 191-192).
• Completing a 1-semester college-level Transitional or Heritage language course (Spanish 104, 171, French 104, German 104, Italian 106, Chinese 104 or 105, Russian 104).
• Achieving a minimum score of 600 on a College Board Foreign Language Achievement Test
• Achieving a minimum score of 3 or 4 (depending upon the language and the test) on an AP test in a foreign language

Native speakers of English and native speakers of other languages may also demonstrate proficiency in a language other than English by doing one of the following:

• Showing a high school diploma from a country whose language of instruction is other than English
• Passing a proficiency examination administered by the department which houses the appropriate language. Romance Languages and Literatures: French, Spanish, Italian and Portuguese; Classics: Latin, Ancient Greek; Jewish Studies: Hebrew; Linguistics: all other languages taught at UB. It is suggested that students contact the relevant department to arrange for the proficiency examination as soon as they are in residence at UB. For speakers of languages not taught at UB, see the College of Arts and Sciences Office of Student Advisement and Services.

Note: Majors in the following schools and programs are not required to complete language study: Architecture; B.F.A. in Art, Dance, Music Theatre; Bioinformatics and Computational Biology; Biomedical Sciences; Biotechnology; Engineering (except Computer Science); Informatics; Management; Medical Technology; Medicinal Chemistry; Nuclear Medicine Technology; Nursing; Pharmacology and Toxicology; Pharmacy and Pharmaceutical Sciences; Public Health and Health Professions.

Note: Some majors and minors require additional semesters of language study.
**Humanities**

Students completing ENG 101 and ENG 201 have met this requirement; other students must complete one 3-credit course offered from AAS, AS, AMS, CL, COL, ENG (excluding ENG 101/ENG 201), FR, GER, GGS, HIS, HMN, ITA, JDS, LLS, PHI, RSP, SPA, TNS, WLP, and other languages.

Note: Courses used to satisfy any other general education requirement are excluded.

**Arts**

Complete one 3-credit course offered by ART, AHI, DMS, MTR, MUS, TH, or THD; VS; ARC 121 is also an option. (**See note at the end of this section.**)

Note: Courses used to satisfy any other general education requirement are excluded.

**Depth Requirement**

Complete any one of the following:

- Third-semester language proficiency (e.g. SPA 151)
- An additional course from the listing of mathematical sciences courses
- UGC 302 or UGC 303 Great Discoveries in Science
- A natural sciences course numbered 200 or higher
- Any one of the following courses: ANA 407, APY 310, APY 328, APY 338, APY 344, APY 345, APY 348, APY 350; ARC 442; CDS 288, CDS 382; GEO 345, GEO 347, GEO 348, GEO 350, GEO 352, GEO 356, GEO 435, GEO 449; MT 402; PSY 351, PSY 402, PSY 434, PSY 435, PSY 436, PSY 439

Note: Courses used to satisfy any other general education requirement are excluded. Transfer courses must be articulated (i.e., matched) to specific UB courses or requirements in order to satisfy UB’s Depth Requirement. SUNYGE waivers do not apply toward UB’s Depth Requirement. Students may not petition this policy.
**Note: Students who entered UB with 24 or more transferable credit hours from an institution of higher education other than UB are exempted from the World Civilizations, American Pluralism, and Arts requirements. These credits must have been earned prior to enrollment at UB.

General Education Requirements

Requirements differ by student status. Please note that there are different requirements for: (1) students who enter as freshmen; (2) students who enter as transfer students; (3) students who enter as transfer students with a completed AA or AS degree from a SUNY institution and with a GETA (General Education Transcript) showing completion of all SUNY general education requirements; (4) re-entering students who were recently enrolled at UB; (5) re-entering students last enrolled more than five years ago; (6) students enrolled for a second bachelor’s degree; (7) students enrolled who have a completed bachelor’s degree from a foreign institution; and (8) students with a registered learning disability. See an academic advisor for details.

General Education Advising Notes

S/U grading is not an option in any course used to satisfy General Education requirements. Internship, Independent Study, Undergraduate Teaching, Experiential Learning, and other courses not based on classroom experiences may not be used to meet General Education requirements.

Any given course may be applied toward only one General Education requirement unless explicitly noted otherwise.

Only the specified courses or those that articulate to the specified courses listed for each respective General Education requirement may be used to fulfill that particular requirement. No other courses qualify.

SUNY has established *minimum* General Education requirements for campuses across the SUNY system. UB’s General Education program meets, and in many cases exceeds, these requirements. Students should understand that meeting SUNY General Education requirements at other campuses does not necessarily mean that they have met all of UB’s requirements or that they are exempt from certain UB requirements.
V. GENERAL GUIDELINES

The recommended course sequences given in Sec. III are to be used as guidelines. It is not necessary to follow them precisely; however, if you wish to deviate from them it is essential that you check with the Undergraduate Director, Professor Weinstein, before doing so. This is especially important if you are signed up for the Finish in Four plan. This will prevent you from making a serious mistake. Here are a few general guidelines:

(i) Take Modern Physics (PHY 401–402) in the Junior year. It is necessary to have taken PHY401 before taking Advanced Lab (PHY 407, 408), Nuclear and Particle Physics (PHY 412), or Solid State Physics (PHY 434 or PHY 527–528).

(ii) Take two semester courses such as PHY 301–302 in sequence rather than waiting a year to take the second semester. This ensures continuity.

(iii) Distribute physics, math and other technical courses as evenly as possible throughout your program. This makes life easier.

(iv) Take MTH 309 Introductory Linear Algebra even if you are not a Mathematical Physics or Computational Physics Major. This course helps greatly in understanding quantum mechanics and certain areas of classical mechanics.

(v) Consider taking a Minor in Math. If you pursue the BS in Physics it is only necessary to add MTH 309 to your program in order to complete this minor.

(vi) Take some sort of computer–based course so as to develop at least minimal programming skills, and some knowledge of numerical methods. If possible, take at least one semester of PHY 410–411, Computational Physics.

(viii) Consult with the Undergraduate Director, Professor Weinstein, on a regular basis so as to make sure that you are fulfilling the requirements of the major. Those signed up for the Finish in Four plan must make an appointment with their advisor within the first 3 weeks of each term. Engineering Physics students should also consult with a SEAS Advisor in 410 Bonner Hall. For problems arising in connection with General Education Requirements, it is best to consult with Ms. Pamela Wendling, Senior Academic Advisor, Natural Sciences Services (pwendlin@buffalo.edu, 645–6883, 275 Park Hall). She is on the staff of the Dean of the College of Arts and Sciences.

(ix) Check your HUB AAR report regularly. If you find what appears to be an error in your report, bring it to Professor Weinstein’s attention.
VI. PROCEDURES FOR APPLYING TO DEGREE PROGRAMS

For the BS, BA, and Minor in Physics; as well as the BS in Mathematical Physics, the BS in Computational Physics, the 5 year BS in Computational Physics/MS in Physics, and the BA’s in the Teaching of Science; the application to a degree program is processed by the Undergraduate Director for Physics, Professor Weinstein. Simply inform him of your intended physics major, and that you have finished the prerequisite courses with the required GPA. After confirming this on your HUB record, he will accept you to this major. For the Teaching of Science programs an application for the Minor in Education must be filed with the Teacher Education Institute (TEI) in 379 Baldy Hall.

The application for the Engineering Physics program is initiated either through Professor J. Bird (312 Bell Hall; 645–2422 X 2132) of the Electrical Engineering Department, or through SEAS Undergraduate Student Services in 410 Bonner Hall.

Upon being accepted into a degree program, the student will receive an e-mail confirming the acceptance. Once accepted be sure to check with the Undergraduate Director (Professor Weinstein) at least once a semester before registering for the following semester. Again for Finish in Four, you must do this.

VII. DEPARTMENT HONORS AND SENIOR THESIS

In order to graduate with Departmental Honors a student must excel in course work as well as complete a Senior Thesis. The designations given below are awarded to students who have the corresponding grade point averages in courses required for the degree programs of the Department of Physics and have completed a Senior Thesis.

<table>
<thead>
<tr>
<th>Designation</th>
<th>GPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honors</td>
<td>3.25</td>
</tr>
<tr>
<td>High Honors</td>
<td>3.50</td>
</tr>
<tr>
<td>Highest Honors</td>
<td>3.75</td>
</tr>
</tbody>
</table>

The Senior Thesis is prepared under the supervision of a Department of Physics faculty member. Credit for this is obtained through PHY 497–Honors. The thesis is reviewed by the student’s mentor and the Undergraduate Director.

Those students who successfully complete the Physics Honors Program will receive recognition at graduation, and awards will be given at the reception held each year for the BA and BS recipients of the Department of Physics.
VIII. UNDERGRADUATE RESEARCH

Most of the faculty of the Department of Physics are willing to engage undergraduate students in their research activities. Interested students should check out the web page located at http://www.physics.buffalo.edu/undergraduate/UndergraduateResearchMentors.htm. This web page describes the Undergraduate Research Mentors program of the Department of Physics. Students can get credit for undergraduate research by registering for PHY 498 Undergraduate Research.

There are also many opportunities for undergraduates to pursue research at UB, through the university’s Center for Undergraduate Research and Creative Activities (CURCA). You may inquire at http://curca.buffalo.edu.

Another way to get research experience is to participate in the Research Experiences for Undergraduates (REU) program sponsored by the National Science Foundation (NSF). With this program various universities provide summer research opportunities for undergraduate students. The list of universities that have such a program is at http://www.nsf.gov/home/crssprgm/reu/. The web page for each program describes how to apply, along with the research areas and stipends that are available. Besides the stipend many programs provide housing and a travel allowance.

IX. ADVICE ON GRADUATE SCHOOL

Most physics students go on to graduate school after they complete their BA or BS degree. If you plan to do so, you should begin making preparation in the spring of your junior year.

You can obtain information on graduate programs from sources such as Graduate Programs in Physics, Astronomy, and Related Fields (American Institute of Physics; Woodbury, New York), Graduate Programs in the Physical Sciences, Mathematics & Agricultural Sciences (Peterson’s; Princeton, New Jersey), as well as brochures from physics departments. The Department of Physics keeps a file of brochures that you are free to examine. Probably the best way to obtain information is by talking to professors in our department, and if possible, to professors in other physics departments. Most departments are happy to have you visit them. In recent years the World Wide Web has become an invaluable source of information on graduate programs.

Many graduate programs require you to take the Graduate Record Exam (GRE), which is administrated by the Educational Testing Service. Their address is:

Graduate Record Examinations
Educational Testing Service
PO Box 6000
Princeton, NJ 08541-6000

Information on the exams can be obtained by telephoning the Educational Testing Service on 1–866–
For physics students there are two GRE's of interest, the General Test and the Physics Test. It is important to study for the GRE. You should obtain an old exam, and use it to guide you in your studying, as well as for practice.

Most graduate programs have deadlines for their applications that occur in January or early February. It is important that you get your applications in on time. In general it is necessary to provide three or four letters of recommendation from professors who have taught you, or that you have worked with during your undergraduate years. In this connection it is important to make yourself known. If the only thing a professor knows about you is your grade in a course, he or she cannot write a very useful letter. If at all possible you should get involved in the research activities of one or more faculty members; either by working for them, or by doing a Senior Thesis. If you decide to do a Senior Thesis you should start work in the fall of your senior year, if not sooner, as this gives a faculty member time to get to know you before writing a letter of recommendation. It is a good idea to provide a résumé and a transcript to anyone that you ask to write a letter of recommendation.

Graduate students are usually supported by teaching assistantships (TA's), research assistantships (RA's), by fellowships, or a combination of these. It is safe to say that a physics student from UB with a B or better average in the courses required by the Department of Physics can get into a reputable graduate program in physics, that will provide a TA. In general a TA includes a tuition waiver and a modest salary. Some graduate programs also guarantee summer employment, as well as health benefits.

There are two types of fellowships; those that are offered by the graduate programs, and national fellowships. Obviously, graduate programs offer their fellowships to their best applicants. In general, the national fellowships can be used for any graduate program that accepts you. In fact getting such fellowships improves your chance of acceptance. Information on the national fellowships can be obtained from the office of the University Honors Program 106 Capen Hall, http://honors.buffalo.edu, or http://fellowships.buffalo.edu.. Below is a list of well-known national fellowships:

Danforth Foundation
Hertz Foundation
National Science Foundation Graduate Research Fellowship
Department of Defense - National Defense Science & Engineering Graduate Fellowship Program (NDSEG)
Fulbright Fellowship
Goldwater Fellowship
APPENDIX A.

ACCEPTANCE CRITERIA FOR TRANSFER STUDENTS

1. Transfer students from accredited institutions will be granted admission to the Department of Physics if they satisfy the following requirements with an average of 2.0 or better:

   a. A one-year calculus-based physics course similar to our PHY 107-108/158.
   b. A one-year calculus course similar to MTH 141-142.

2. For transfer students with more than the minimum course work listed in 1a & b, admission will be granted if the student has an average of 2.0 or better in all physics and mathematics courses previously attempted.

3. Academic Transfer credit will be granted for physics and mathematics courses, suitable to our degree programs, only for those courses in which the grade was C or better.

APPENDIX B.

COURSE DESCRIPTIONS

PHY 100 Introduction to Physics
Credits: 1
Semester: Su
Prerequisites: None
Corequisites: None
Type: LEC
Repeatable: No
Note: None
Preparation for PHY 107-PHY 108 or PHY 101-PHY 102. Covers mostly Newtonian mechanics, emphasizing problem solving and math skills useful for physics. Reviews algebra, geometry, and trigonometry as applied to physics.

PHY 101 College Physics
Credits: 4
Semester: F Sp
Prerequisites: None
Corequisites: PHY 151
Type: LEC/REC
Repeatable: No
Note: None
Presents non-calculus, introductory physics, including mechanics, heat, waves, and sound.

PHY 102 College Physics II
Credits: 4
Semester: Sp
Prerequisites: PHY 101
Corequisites: PHY 152
Type: LEC/REC
Repeatable: No
Note: None
Presents non-calculus, introductory physics, including electricity and magnetism, light, optics, and modern physics.

PHY 107 General Physics I
Credits: 4
Semester: F Sp
Prerequisites: None
Corequisites: MTH 141
Type: LEC/REC
Repeatable: No
Note: None
A calculus-based introductory course primarily for chemistry, engineering, and physics majors. Covers kinematics, Newton's laws, energy, momentum, rotational motion, and oscillations.

PHY 108 General Physics II
Credits: 4
Semester: F Sp
Prerequisites: PHY 107
Corequisites: MTH 142, PHY 158
Type: LEC/REC
Repeatable: No
Note: None
A calculus-based introductory course primarily for chemistry, engineering, and physics majors. Covers the electric field, Gauss’ law, electric potential, capacitance, DC circuits, RC circuits, magnetic field, Faraday’s law, inductance, LR circuits, AC circuits, and Maxwell’s equations.

PHY 115 Relativity Seminar for Nonspecialists
Credits: 3
Semester: F
Prerequisites: None
Corequisites: None
Type: SEM
Repeatable: No
Note: None
Examines philosophies of space and time, Mach’s principle and the role of inertia, curved space-time, unified field theory (Faraday to Einstein), and implications of extension in all domains.

PHY 116 Philosophy of Physics
Credits: 3
Semester: Sp
Prerequisites: None
Corequisites: None
Type: LEC
Repeatable: No
Note: None
Studies views of space, time, and matter in the ancient world; European post-Renaissance, nineteenth-century ideas and discoveries; wave-particle dualism; wave mechanics; Copenhagen school; theory of relativity; and problems of matter, radiation, and cosmology.

PHY 117 Honors Physics I
Credits: 4
Semester: Sp
Prerequisites: None
Corequisites: MTH 141
Type: LEC/REC
Repeatable: No
Note: None
Covers the same topics as PHY 107, but in greater depth. Class size is limited. In general, taken by students in the University Honors Program, but other students may take it with permission of instructor.

PHY 118 Honors Physics II
Credits: 4
Semester: F
Prerequisites: PHY 107 or PHY 117
Corequisites: MTH 142, PHY 158
Type: LEC/REC
Repeatable: No
Note: None
Covers the same topics as PHY 108, but in greater depth. Class size is limited. In general, taken by students in the University Honors Program, but other students may take it with permission of instructor.

PHY 119 How Things Work
Credits: 3
Semester: F
Prerequisites: None
Corequisites: None
Type: LEC
Repeatable: No
Note: None
Describes working principles of devices used in everyday life, such as the video recorder, fax machine, and television. Reviews the history of discoveries that made each device possible, as well as development of the device. Explores the consequences of particular devices in society. Suitable for non-science majors, but science and engineering majors are expected to greatly benefit from it also.

PHY 121 Descriptive Astronomy I
Credits: 3 - 4
Semester: F
Prerequisites: None
Corequisites: None
Type: LEC/LAB
An introduction to astronomy, covering scales in the universe, constellations and the night sky, the history of astronomy from ancient times to the present, astronomical instrumentation, spectroscopy, the birth and evolution of stars, white dwarfs, neutron stars, and black holes.

**PHY 122 Descriptive Astronomy II**
Credits: 3 - 4  
Semester: Sp  
Prerequisites: PHY 121  
Corequisites: None  
Type: LEC/LAB  
Repeatable: No  
Note: None  
A continuation of PHY121, covering the Milky Way Galaxy, other galaxies in the universe, cosmology and the origin of the universe, the formation of the solar system, earthlike planets, planets of the outer solar system, meteorites, asteroids, and comets. The theme of the class is origins: How did the universe begin? What was the origin of the earth? How did life begin?

**PHY 151 College Physics I Lab**
Credits: 1  
Semester: F  
Prerequisites: None  
Corequisites: PHY 101  
Type: LAB  
Repeatable: No  
Note: None  
Studies mechanics, heat, waves, and sound.

**PHY 152 College Physics II Lab**
Credits: 1  
Semester: Sp  
Prerequisites: None  
Corequisites: PHY 102  
Type: LAB  
Repeatable: No  
Note: None  
Studies electricity and magnetism, light, optics, and modern physics.

**PHY 158 General Physics II Lab**
Credits: 1  
Semester: F Sp  
Prerequisites: PHY 107  
Corequisites: PHY 108  
Type: LAB  
Repeatable: No  
Note: None  
Conducts experiments on mechanics, as well as electricity and magnetism.

**PHY 207 General Physics III**
Credits: 4  
Semester: Sp  
Prerequisites: PHY 107-PHY 108  
Corequisites: MTH 241  
Type: LEC  
Repeatable: No  
Note: None  
Examines sound waves, electromagnetic waves, and geometrical and physical optics. Introduces modern physics, including discovery of the electron, the photon, wave-particle duality, the Bohr model of H-atom, the Schrödinger equation, quantum numbers, the Pauli principle and periodic table, and lasers.

**PHY 208 General Physics IV**
Credits: 3  
Semester: F  
Prerequisites: PHY 107, PHY108  
Corequisites: MTH 306  
Type: LEC  
Repeatable: No  
Note: None  
Examines thermodynamics, including temperature, zeroth law, thermal expansion, specific heat, first law, second law, entropy, third law, kinetic theory, Brownian motion, and the ideal gas. Also explores special relativity, including historical background, Lorentz transformations, length contraction, time dilation, invariance of the laws of physics, relativistic dynamics and kinematics, and paradoxes.
PHY 217 Honors Physics III  
Credits: 3  
Semester: Sp  
Prerequisites: PHY 107 and PHY 108, or PHY 117 and PHY 118  
Corequisites: MTH 241  
Type: LEC  
Repeatable: No  
Note: None  
Covers the same topics as PHY 207, but in greater depth. Class size is limited. In general, taken by students in the University Honors Program, but other students may take it with permission of instructor.

PHY 257 General Physics III Lab  
Credits: 1  
Semester: Sp  
Prerequisites: PHY 107 and PHY 108/PHY 158, or PHY 117 and PHY 118/PHY 158  
Corequisites: PHY 207  
Type: LAB  
Repeatable: No  
Note: None  
Conducts experiments on waves, geometrical and physical optics, and modern physics.

PHY 286 Maple in Physics  
Credits: 1  
Semester:  
Prerequisites: PHY 107-PHY 108  
Corequisites: None  
Type: LAB  
Repeatable: No  
Note: None  
Introduces basic syntax and capabilities of this computer calculus/algebra system as applied to obtain analytical solutions to problems in physics. Students taking PHY386 learn the same syntax as PHY 286 students, but are required to do more advanced problems such as occur in junior-senior physics courses. A student may receive academic credit for only one of the two courses.

PHY 301 Intermediate Mechanics I  
Credits: 3  
Semester: F  
Prerequisites: PHY 107 and MTH 306  
Corequisites: None  
Type: LEC  
Repeatable: No  
Note: None  
Covers vector calculus, kinematics, studies of rigid bodies and cables, the virtual work principle, damped and forced harmonic oscillators, dynamics of systems of particles, conservation laws, and dynamics of rigid bodies in planar motion.

PHY 302 Intermediate Mechanics II  
Credits: 3  
Semester: Sp  
Prerequisites: PHY 301  
Corequisites: None  
Type: LEC  
Repeatable: No  
Note: None  

PHY 307 Modern Physics Lab  
Credits: 2  
Semester: Sp  
Prerequisites: PHY 207 or PHY 217; PHY 208, PHY 257  
Corequisites: None  
Type: LAB  
Repeatable: No  
Note: None  
Conducts experiments in thermodynamics and modern physics.

PHY 311 Applied Acoustics of Music  
Credits: 3  
Semester:  
Prerequisites: None  
Corequisites: None  
Type: LEC  
Repeatable: No  
Note: None  
A general, practical course. Covers the nature
of sound; the ear and the hearing process; consonance and dissonance; scales and harmonic series; basic physics of musical instruments; high fidelity systems; and theatre, studio, and room acoustics.

**PHY 386 Maple in Physics**
Credits: 1
Semester: Sp
Prerequisites: PHY 107, PHY 108, PHY 207, PHY 208, and junior standing
Corequisites: None
Type: LAB
Repeatable: No
Note: None

Introduces basic syntax and capabilities of the computer calculus/algebra system as applied to obtain analytical solutions to problems in physics. Students taking PHY 386 learn the same syntax as PHY 286 students, but are required to do more advanced problems such as occur in junior-senior physics courses. A student may receive academic credit for only one of the two courses.

**PHY 401 Quantum Mechanics I Fundamentals**
Credits: 3
Semester: F
Prerequisites: MTH 306, PHY 207
Corequisites: None
Type: LEC
Repeatable: No
Note: None

Origins of quantum theory; wave function and uncertainty principle; Schrödinger equation; one-dimensional examples; formalism of quantum mechanics.

**PHY 402 Quantum Mechanics II Applications**
Credits: 3
Semester: Sp
Prerequisites: PHY 401
Corequisites: None
Type: LEC
Repeatable: No
Note: None

Angular momentum; three-dimensional problems; hydrogen atom; time-independent perturbation theory; electron spin and fine structure; time-dependent perturbation theory; quantum statistics.

**PHY 403 Electricity and Magnetism I**
Credits: 3
Semester: F
Prerequisites: MTH 241, MTH 306, PHY 108
Corequisites: None
Type: LEC
Repeatable: No
Note: None

Examines vector calculus, Gauss’ law, scalar and vector potentials, Laplace and Poisson’s equations, dielectrics, electrostatic and magnetostatic fields, Ampere’s law, Faraday’s law, and Maxwell’s equations.

**PHY 404 Electricity and Magnetism II**
Credits: 3
Semester: Sp
Prerequisites: PHY 403
Corequisites: None
Type: LEC
Repeatable: No
Note: None

Undertakes further study of Maxwell’s equations, electric and magnetic susceptibilities, electromagnetic radiation, electromagnetic fields from a moving charge, waveguides and transmission lines, Poynting’s vector, and Lorentz force. Also examines relativistic invariance.

**PHY 405 Thermal and Statistical Physics I**
Credits: 3
Semester: F
Prerequisites: MTH 306, PHY 208, PHY 301
Corequisites: None
Type: LEC
Repeatable: No
Note: None

Explores statistics and statistical description
of particles; statistical and macroscopic thermodynamics; basic results of classical statistical mechanics and connections with thermodynamics; microcanonical, canonical, and grand canonical ensembles; applications to ideal gases, paramagnets, and lattice vibrations; kinetic theory; and phase equilibrium of one-component systems.

PHY 406 Thermal and Statistical Physics II
Credits: 3
Semester: Sp (alternate years)
Prerequisites: PHY 207 or PHY 217; PHY 401, PHY 405
Corequisites: None
Type: LEC
Repeatable: No
Note: None
Critical behavior at continuous phase transitions. Quantum statistics of ideal Bose and Fermi systems, applications to electrons in metals, blackbody radiation, Bose condensation, neutron stars, interacting systems, lattice vibrations, nonideal gases, ferromagnets, kinetic theory of transport processes, irreversible processes, and fluctuations.

PHY 407 Advanced Laboratory
Credits: 3
Semester: F
Prerequisites: PHY 207 or PHY 217; PHY 208, PHY 257, PHY 307, PHY 401
Corequisites: None
Type: LAB
Repeatable: Yes
Note: None
Covers modern physics, with a choice of experiments: atomic physics, modern laser optics, solid state, magnetic resonance, X-ray diffraction, scanning probe microscopy, nuclear, or particle physics. Two four-hour labs each week.

PHY 408 Advanced Laboratory
Credits: 3
Semester: Sp
Prerequisites: PHY 207 or PHY 217; PHY 208, PHY 257, PHY 307, PHY 401
Corequisites: None
Type: LAB
Repeatable: Yes
Note: None

PHY 410 Computational Physics I
Credits: 3
Semester: F
Prerequisites: PHY 207 or PHY 217; PHY 401
Corequisites: None
Type: LEC
Repeatable: Yes
Note: None
Examines numerical solutions of problems in dynamics, electrodynamics, and quantum and statistical physics. Also examines root-finding, numerical differentiation, quadrature, matrix inversion, and ordinary differential equations. Studies structured programming in FORTRAN 90, C++, or Java; and explores Computer graphics.

PHY 411 Computational Physics II
Credits: 3
Semester: Sp
Prerequisites: PHY 410
Corequisites: None
Type: LEC
Repeatable: No
Note: None
Examines numerical solutions of problems in dynamics, electrodynamics, and quantum and statistical physics. Also examines root-finding, numerical differentiation, quadrature, matrix inversion, and ordinary differential equations. Studies structured programming in FORTRAN 90, C++, or Java; and explores Computer graphics.

PHY 412 Nuclear and Particle Physics
Credits: 3
Semester: Sp
Prerequisites: PHY 401
Explores fundamentals of nuclear physics, including interaction of radiation with matter; properties of nuclear forces; nuclear structure described by shell and collective models; nuclear reactions; radioactive decay processes; and properties of elementary particles.

**PHY 413 Electronics**  
Credits: 3  
Semester: Sp  
Prerequisites: PHY 108 or permission of instructor  
Corequisites: None  
Type: LEC/LAB  
Repeatable: No  
Note: None  
Introduces basic concepts of circuit design, impedance, and feedback systems; solid-state components; integrated circuits; digital circuits; and basic instrumentation.

**PHY 414 Experimental Techniques**  
Credits: 2 - 3  
Semester: F  
Prerequisites: permission of instructor  
Corequisites: None  
Type: TUT  
Repeatable: No  
Note: None  
Involves individual work with faculty in a research laboratory.

**PHY 415 Experimental Techniques**  
Credits: 2 - 3  
Semester: Sp  
Prerequisites: permission of instructor  
Corequisites: None  
Type: TUT  
Repeatable: No  
Note: None  
Involves individual work with faculty in a research laboratory.

**PHY 425 Intermediate Optics**  
Credits: 3  
Semester: F  
Prerequisites: PHY 207 or PHY 217  
Corequisites: None  
Type: LEC  
Repeatable: No  
Note: None  
Examines geometrical and physical optics. Explores diffraction, interference, polarization, and other wave properties of light; and the quantum nature of light and lasers.

**PHY 431 Introduction to Mathematical Physics 1**  
Credits: 3  
Semester: F  
Prerequisites: MTH 417, 418  
Corequisites: None  
Type: LEC  
Repeatable: No  
Note: None  
This course covers fundamentals of Mathematical Physics. It includes the following topics: linear algebra, multiple integrals, Fourier series and transforms, Calculus of variation, Special functions, and Partial Differential Equations. All topics are covered in the context of specific application and problem solving in Classical Mechanics, Quantum Mechanics, Electrodynamics and Fluid Dynamics.

**PHY 434 Solid State Physics**  
Credits: 3  
Semester: Sp (alternate years)  
Prerequisites: PHY 401, 405  
Corequisites: None  
Type: LEC  
Repeatable: No  
Notes: None  
A one semester undergraduate introductory course in solid state physics that covers the following topics: crystal structures, diffraction of waves by crystals, crystal binging, phonons in crystals, thermal properties of phonons, free electron Fermi
gas, energy bands in crystals, semiconductor crystals, optical properties, devices, magnetism, nanostructures.

**PHY 480 Special Topics in Physics**
Credits: 1-3
Semester: F Sp
Prerequisites: None
Corequisites: None
Type: LEC
Repeatable: Yes
Note: None
From time to time courses will be offered on topics not covered in regularly offered physics courses.

**PHY 497 Honors**
Credits: 3
Semester: F Sp
Prerequisites: None
Corequisites: None
Type: TUT
Repeatable: No
Note: None
For students who wish to do a senior thesis. Consult the Undergraduate Director, Professor Weinstein, for details.

**PHY 498 Undergraduate Research**
Credits: 1 - 3
Semester: F Sp
Prerequisites: None
Corequisites: None
Type: TUT
Repeatable: Yes
Note: None
This course allows students to get credit for research activities carried out under the supervision of a faculty member of the Department of Physics.

**PHY 499 Independent Study in Physics**
Credits: 1 - 4
Semester: F Sp
Prerequisites: None
Corequisites: None
Type: TUT
Repeatable: Yes