Physics examines the fundamental principles that govern natural phenomena, ranging in scale from collisions of subatomic particles, through the behavior of solids, liquids, and biomolecules, to exploding stars and colliding galaxies. The program aims to help students experience the intellectual stimulation of studying physics and the excitement of frontline research; understand the basic principles and techniques of physics-related careers; and prepare for graduate study in physics or related fields.

The department offers several degree programs: BS in physics, applied physics, or biomedical physics; BS in applied physics/MS in electrical engineering; MS and PhD in physics. Four levels of courses are offered: descriptive courses for nonscience majors with limited mathematical background; general survey courses for students in scientific and engineering fields; advanced courses primarily intended for physics, biomedical physics, and applied physics majors; and highly advanced courses primarily intended for prospective graduate students.

A BS, MS, or a PhD degree in physics offers many career opportunities in industrial, government, and academic high-technology laboratories as scientists or engineers. Many physics majors pursue advanced degrees in physics and related fields.

BS students have the option of majoring in several programs in addition to the general physics program, including programs in applied physics and biomedical physics. These programs are expanding as the need for students trained in biotechnology and nanotechnology is rapidly growing.

The biomedical physics program seeks to understand the role of physical processes occurring on molecular, cellular, or macroscopic scales, in vital biological functions, ranging from the interaction of chemicals with DNA, to the extraction of oxygen from red blood cells, to the generation of complex electrical signals in the brain and nervous system. Biomedical physics also examines how physical principles and modern instrumentation techniques can be used in medical applications.

The program in applied physics promotes study of physical processes at nanoscale dimensions. This field has many applications, including developing new green technologies, such as improving solar light-to-electricity conversion; using sunlight to split water into hydrogen and oxygen for fuel cell technologies; building future devices for information technology such as quantum computers; and many medical applications of nanoscience to improve disease diagnosis and treatment.

An additional option is the BS/MS program in applied physics and engineering, jointly sponsored by the Department of Physics and the Department of Electrical and Computer Engineering (ECE). Students are offered strong interdisciplinary training in physics, math, and electrical engineering to achieve a BS degree in applied physics and take graduate courses in ECE in the fourth and fifth years that lead directly to an MS degree in electrical engineering.

Students also have the opportunity to combine physics with another discipline through a dual major. Current dual majors with physics include chemical engineering, computer science, electrical engineering, environmental geology, geology, mathematics, and philosophy.

Transferring to the Major
Same as college standards. Acceptance into the major is based on students’ meeting the department’s criteria for admission and availability of space in the programs.

Academic Progression Standards
Students may not continue as physics majors beyond the end of the sophomore year unless the following courses are successfully completed:

- **PHYS 1161** Physics 1 4 SH
- with **PHYS 1162** Lab for PHYS 1161 1 SH
- **PHYS 1165** Physics 2 4 SH
- with **PHYS 1166** Lab for PHYS 1165 1 SH
- **PHYS 2303** Modern Physics 4 SH
- **PHYS 2305** Thermodynamics and Statistical Mechanics 4 SH
- **PHYS 2371** Electronics 4 SH
- **MATH 1341** Calculus 1 for Science and Engineering 4 SH
- **MATH 1342** Calculus 2 for Science and Engineering 4 SH
- **MATH 2321** Calculus 3 for Science and Engineering 4 SH
- **MATH 2351** Ordinary Differential Equations 4 SH

or equivalent courses. Note: The following courses may be taken in place of PHYS 1161, PHYS 1162, PHYS 1165, and PHYS 1166:

- **PHYS 1151** Physics for Engineering 1 4 SH
- with **PHYS 1152** Lab for PHYS 1151 1 SH
- **PHYS 1155** Physics for Engineering 2 4 SH
- with **PHYS 1156** Lab for PHYS 1155 1 SH

A minimum GPA of 2.500 must be achieved in these courses to remain in the major.

Students may not graduate from the physics program unless all required physics, math, and science courses are passed with a GPA of 2.500 or more. Further, no more than two grades of D+ or lower may be counted toward the graduation requirements.
BS in Physics

NU CORE REQUIREMENTS
See page 26 for requirement list.

BREADTH COURSES FOR PHYSICS

Mathematics
Complete the following six courses:
MATH 1341 Calculus 1 for Science and Engineering 4 SH
MATH 1342 Calculus 2 for Science and Engineering 4 SH
MATH 2321 Calculus 3 for Science and Engineering 4 SH
MATH 2331 Linear Algebra 4 SH
MATH 2351 Ordinary Differential Equations 4 SH
MATH 3081 Probability and Statistics 4 SH

General Engineering
Complete the following engineering course:
GE 1111 Engineering Problem Solving and Computation 4 SH

Chemistry
Complete the following chemistry course with corresponding lab:
CHEM 1211 General Chemistry 1 4 SH
with CHEM 1212 Lab for CHEM 1211 1 SH

Technical Electives
Complete 8 semester hours of intermediate or advanced courses from the following list:
BIOL 2301 to BIOL 5999
CHEM 2311 to CHEM 5999
CHME 2001 to CHME 4699
CIVE 2001 to CIVE 4699
CS 2990 to CS 4900
EECE 2001 to EECE 5999
ENVR 2300 to ENVR 5999
IE 2001 to IE 4699
MATH 2280 Statistics and Software 4 SH
MATH 2285 Introduction to Multisample Statistics 4 SH
MATH 2321 to MATH 5999
ME 2001 to ME 4699
PHYS 2303 to PHYS 5999

PHYSICS MAJOR REQUIREMENTS

Introductory Physics
Complete a lecture/lab set for Physics 1 and for Physics 2:
PHYSICS 1
PHYS 1161 Physics 1 4 SH
with PHYS 1162 Lab for PHYS 1161 1 SH
or PHYS 1151 Physics for Engineering 1 4 SH
with PHYS 1152 Lab for PHYS 1151 1 SH

PHYSICS 2
PHYS 1165 Physics 2 4 SH
with PHYS 1166 Lab for PHYS 1165 1 SH
or PHYS 1155 Physics for Engineering 2 4 SH
with PHYS 1156 Lab for PHYS 1155 1 SH

Intermediate Physics
Complete the following three courses:
PHYS 2303 Modern Physics 4 SH
PHYS 2305 Thermodynamics and Statistical Mechanics 4 SH
PHYS 2371 Electronics 4 SH

Advanced Physics
Complete the following five courses:
PHYS 3600 Advanced Physics Laboratory 1 4 SH
PHYS 3601 Classical Dynamics 4 SH
PHYS 3602 Electricity and Magnetism 4 SH
PHYS 3603 Electromagnetic Waves and Optics 4 SH
PHYS 5115 Quantum Mechanics 4 SH

Elective Course
Complete one course from the following list:
MATH 4606 Mathematical and Computational Methods for Physics 4 SH
PHYS 3500 Physics with Computers 4 SH
PHYS 4606 Mathematical and Computational Methods for Physics 4 SH
PHYS 4621 Biological Physics 1 4 SH
PHYS 4623 Medical Physics 4 SH
PHYS 4651 Medical Physics Seminar 1 4 SH
PHYS 4652 Medical Physics Seminar 2 4 SH
PHYS 5113 Introduction to Particle and Nuclear Physics 4 SH
PHYS 5260 Introduction to Nanoscience and Nanotechnology 4 SH

Experiential Education
Complete the following course:
PHYS 4996 Experiential Education Directed Study 4 SH

Senior Capstone
Complete the following course:
PHYS 5318 Principles of Experimental Physics 4 SH

PHYSICS MAJOR CREDIT REQUIREMENT
Complete 95 semester hours in the major.

GENERAL ELECTIVES
Additional courses taken beyond college and major course requirements to satisfy graduation credit requirements.

COOPERATIVE EDUCATION
If elected

UNIVERSITY-WIDE REQUIREMENTS
128 total semester hours required
Minimum 2.000 GPA required
BS in Applied Physics

NU CORE REQUIREMENTS
See page 26 for requirement list.

BREADTH COURSES FOR APPLIED PHYSICS

Mathematics
Complete the following four courses:
- MATH 1341 Calculus 1 for Science and Engineering 4 SH
- MATH 1342 Calculus 2 for Science and Engineering 4 SH
- MATH 2321 Calculus 3 for Science and Engineering 4 SH
- MATH 2351 Ordinary Differential Equations 4 SH

General Engineering
Complete the following engineering course:
- GE 1111 Engineering Problem Solving and Computation 4 SH

Chemistry
Complete one introductory chemistry course with corresponding lab:
- CHEM 1211 General Chemistry 1 4 SH
  with CHEM 1212 Lab for CHEM 1211 1 SH

Technical Electives
Complete 16 semester hours of intermediate or advanced courses from the following list:
- BIOL 2301 to BIOL 5999
- CHEM 2311 to CHEM 4699
- CHME 2001 to CHME 4699
- CIVE 2001 to CIVE 4699
- CS 2990 to CS 4900
- EECE 2001 to EECE 5999
- ENVR 2300 to ENVR 5999
- IE 2001 to IE 4699
- MATH 2280 Statistics and Software 4 SH
- MATH 2285 Introduction to Multisample Statistics 4 SH
- MATH 2321 to MATH 5999
- ME 2001 to ME 4699
- PHYS 2303 to PHYS 5999

APPLIED PHYSICS MAJOR REQUIREMENTS

Introductory Physics
Complete a lecture/lab set for Physics 1 and for Physics 2:
- PHYSICS 1
  PHYSICS 1161 Physics 1 4 SH
  with PHYSICS 1162 Lab for PHYSICS 1161 1 SH
  or PHYSICS 1151 Physics for Engineering 1 4 SH
  with PHYSICS 1152 Lab for PHYSICS 1151 1 SH
- PHYSICS 2
  PHYSICS 1165 Physics 2 4 SH
  with PHYSICS 1166 Lab for PHYSICS 1165 1 SH
  or PHYSICS 1155 Physics for Engineering 2 4 SH
  with PHYSICS 1156 Lab for PHYSICS 1155 1 SH

Intermediate Physics
Complete the following three courses:
- PHYS 2303 Modern Physics 4 SH
- PHYS 2305 Thermodynamics and Statistical Mechanics 4 SH
- PHYS 2371 Electronics 4 SH

Advanced Physics
Complete the following four courses:
- MATH 4606 Mathematical and Computational Methods for Physics 4 SH
  or PHYS 4606 Mathematical and Computational Methods for Physics 4 SH
- PHYS 3600 Advanced Physics Laboratory 1 4 SH
- PHYS 3602 Electricity and Magnetism 4 SH
- PHYS 5260 Introduction to Nanoscience and Nanotechnology 4 SH

Advanced Physics Elective
Complete one course from the following list:
- PHYS 3500 Physics with Computers 4 SH
- PHYS 3601 Classical Dynamics 4 SH
- PHYS 3603 Electromagnetic Waves and Optics 4 SH
- PHYS 4621 Biological Physics 1 4 SH
- PHYS 4623 Medical Physics 4 SH
- PHYS 4651 Medical Physics Seminar 1 4 SH
- PHYS 4652 Medical Physics Seminar 2 4 SH
- PHYS 5113 Introduction to Particle and Nuclear Physics 4 SH
- PHYS 5115 Quantum Mechanics 4 SH

Senior Capstone and Experiential Education
Complete the following two courses:
- PHYS 4996 Experiential Education Directed Study 4 SH
- PHYS 5318 Principles of Experimental Physics 4 SH

EXPERIENTIAL EDUCATION REQUIREMENT
Complete one course in experiential education. Please see department for approved courses.

APPLIED PHYSICS MAJOR CREDIT REQUIREMENT
Complete 91 semester hours in the major.

GENERAL ELECTIVES
Additional courses taken beyond college and major course requirements to satisfy graduation credit requirements.

COOPERATIVE EDUCATION
If elected

UNIVERSITY-WIDE REQUIREMENTS
128 total semester hours required
Minimum 2.000 GPA required
BS in Biomedical Physics

NU CORE REQUIREMENTS
See page 26 for requirement list.

BREADTH COURSES FOR BIOMEDICAL PHYSICS MAJOR

Mathematics
Complete the following four calculus courses:
- MATH 1341 Calculus 1 for Science and Engineering 4 SH
- MATH 1342 Calculus 2 for Science and Engineering 4 SH
- MATH 2321 Calculus 3 for Science and Engineering 4 SH
- MATH 2351 Ordinary Differential Equations 1 SH

General Engineering
Complete the following engineering course:
- GE 1111 Engineering Problem Solving and Computation 4 SH

Biology
Complete the following two courses with corresponding labs:
- BIOL 1111 General Biology 1 4 SH
  with BIOL 1112 Lab for BIOL 1111 1 SH
- BIOL 1113 General Biology 2 4 SH
  with BIOL 1114 Lab for BIOL 1113 1 SH

Chemistry
Complete the following course with corresponding lab:
- CHEM 1211 General Chemistry 1 4 SH
  with CHEM 1212 Lab for CHEM 1211 1 SH

Technical Electives
Complete two intermediate or advanced courses from the following list:
- BIOL 2301 to BIOL 5999
- CHEM 2311 to CHEM 5999
- CHME 2001 to CHME 4699
- CIVE 2001 to CIVE 4699
- CS 2990 to CS 4900
- EECE 2001 to EECE 5999
- ENVR 2300 to ENVR 5999
- IE 2001 to IE 4699
- MATH 2280 Statistics and Software 4 SH
- MATH 2285 Introduction to Multisample Statistics 4 SH
- MATH 2321 to MATH 5999
- ME 2001 to ME 4699
- PHYS 2303 to PHYS 5999

BIOMEDICAL PHYSICS MAJOR REQUIREMENTS

Introductory Physics
Complete a lecture/lab set for Physics 1 and for Physics 2:
- PHYS 1161 Physics 1 4 SH
  with PHYS 1162 Lab for PHYS 1161 1 SH
- PHYS 1151 Physics for Engineering 1 4 SH
  with PHYS 1152 Lab for PHYS 1151 1 SH
- PHYS 1165 Physics 2 4 SH
  with PHYS 1166 Lab for PHYS 1165 1 SH
- PHYS 1155 Physics for Engineering 2 4 SH
  with PHYS 1156 Lab for PHYS 1155 1 SH

Intermediate Physics
Complete the following three courses:
- PHYS 2303 Modern Physics 4 SH
- PHYS 2305 Thermodynamics and Statistical Mechanics 4 SH
- PHYS 2371 Electronics 4 SH

Advanced Physics
Complete the following three courses:
- PHYS 3600 Advanced Physics Laboratory 1 4 SH
- PHYS 3602 Electricity and Magnetism 4 SH
- PHYS 3603 Electromagnetic Waves and Optics 4 SH

Biomedical Physics
Complete the following four courses:
- PHYS 4621 Biological Physics 1 4 SH
- PHYS 4623 Medical Physics 4 SH
- PHYS 4651 Medical Physics Seminar 1 4 SH
- PHYS 4652 Medical Physics Seminar 2 4 SH

Senior Capstone and Experiential Education
Complete the following two courses:
- PHYS 4996 Experiential Education Directed Study 4 SH
- PHYS 5318 Principles of Experimental Physics 4 SH

BIOMEDICAL PHYSICS MAJOR CREDIT REQUIREMENT
Complete 101 semester hours in the major.

GENERAL ELECTIVES
Additional courses taken beyond college and major course requirements to satisfy graduation credit requirements.

COOPERATIVE EDUCATION
If elected

UNIVERSITY-WIDE REQUIREMENTS
128 total semester hours required
Minimum 2.000 GPA required
BS in Physics and Philosophy

NU CORE REQUIREMENTS
See page 26 for requirement list.

BREADTH COURSES

Mathematics
Complete the following four courses:
MATH 1341 Calculus 1 for Science and Engineering 4 SH
MATH 1342 Calculus 2 for Science and Engineering 4 SH
MATH 2321 Calculus 3 for Science and Engineering 4 SH
MATH 2341 Differential Equations and Linear Algebra for Engineering 4 SH

PHYSICS REQUIREMENTS FOR DUAL MAJOR

Introductory Physics
Complete a lecture/lab set for Physics 1 and for Physics 2:

PHYSICS 1
PHYS 1161 Physics 1 4 SH
with PHYS 1162 Lab for PHYS 1161 1 SH
or PHYS 1151 Physics for Engineering 1 4 SH
with PHYS 1152 Lab for PHYS 1151 1 SH

PHYSICS 2
PHYS 1165 Physics 2 4 SH
with PHYS 1166 Lab for PHYS 1165 1 SH
or PHYS 1155 Physics for Engineering 2 4 SH
with PHYS 1156 Lab for PHYS 1155 1 SH

Intermediate Physics
Complete the following three courses:

PHYS 2303 Modern Physics 4 SH
PHYS 2305 Thermodynamics and Statistical Mechanics 4 SH
PHYS 2371 Electronics 4 SH

Advanced Physics
Complete the following three courses:

PHYS 3600 Advanced Physics Laboratory 1 4 SH
PHYS 3602 Electricity and Magnetism 4 SH
PHYS 5115 Quantum Mechanics 4 SH

Physics Elective
Complete one elective from the following list:

MATH 4606 Mathematical and Computational Methods for Physics 4 SH
PHYS 3500 Physics with Computers 4 SH
PHYS 4606 Mathematical and Computational Methods for Physics 4 SH
PHYS 4621 Biological Physics 1 4 SH
PHYS 4623 Medical Physics 4 SH
PHYS 4651 Medical Physics Seminar 1 4 SH
PHYS 4652 Medical Physics Seminar 2 4 SH

PHYSICS REQUIREMENTS FOR DUAL MAJOR

PHILOSOPHY REQUIREMENTS FOR DUAL MAJOR

Philosophy Required Courses
Complete the following four courses:
PHIL 1115 Introduction to Logic 4 SH
or PHIL 1215 Symbolic Logic 4 SH
PHIL 2325 Ancient Philosophy 4 SH
PHIL 2330 Modern Philosophy 4 SH
PHIL 4505 Metaphysics 4 SH

Philosophy Seminar
Complete the following philosophy seminar:
PHIL 4902 Great Philosophers Seminar 4 SH

Additional Electives
Complete four additional electives in philosophy.

PHYSICS/PHILOSOPHY INTEGRATIVE REQUIREMENTS

Complete the following two courses:
PHIL 4510 Philosophy of Science 4 SH
PHYS 3601 Classical Dynamics 4 SH

EXPERIENTIAL EDUCATION REQUIREMENT
Complete one course in experiential education. Please see department for approved courses.

PHYSICS AND PHILOSOPHY MAJOR CREDIT REQUIREMENT
Complete 98 semester hours in the major.

GENERAL ELECTIVES
Additional courses taken beyond college and major course requirements to satisfy graduation credit requirements.

COOPERATIVE EDUCATION
If elected

UNIVERSITY-WIDE REQUIREMENTS
128 total semester hours required
Minimum 2.000 GPA required

BS in Computer Science and Physics
See page 292.

BSEE in Electrical Engineering and Physics
See page 317.
BS in Environmental Geology and Physics
For degree requirements, please visit the myNEU Web Portal (www.myneu.neu.edu), click on the “Self-Service” tab, then on “My Degree Audit.”

BS in Geology and Physics
For degree requirements, please visit the myNEU Web Portal (www.myneu.neu.edu), click on the “Self-Service” tab, then on “My Degree Audit.”

BS in Mathematics and Physics
See page 179.

BS/MS in Applied Physics and Engineering

GPA PROGRESSION REQUIREMENT
A GPA of 3.500 is required by the end of year three in order to enroll in graduate EECE courses in year four.

NU CORE REQUIREMENTS
See page 26 for requirement list.

BREADTH COURSES

Mathematics
Complete the following four courses:
MATH 1341 Calculus 1 for Science and Engineering 4 SH
MATH 1342 Calculus 2 for Science and Engineering 4 SH
MATH 2321 Calculus 3 for Science and Engineering 4 SH
MATH 2351 Ordinary Differential Equations 4 SH

General Engineering
Complete one general engineering course:
GE 1111 Engineering Problem Solving and Computation 4 SH

Chemistry
Complete one introductory chemistry course with corresponding lab:
CHEM 1211 General Chemistry 1 4 SH
with CHEM 1212 Lab for CHEM 1211 1 SH

MAJOR REQUIREMENTS

Introductory Physics
Complete a lecture/lab set for Physics 1 and for Physics 2:
PHYSICS 1
PHYS 1161 Physics 1 4 SH
with PHYS 1162 Lab for PHYS 1161 1 SH
or PHYS 1151 Physics for Engineering 1 4 SH
with PHYS 1152 Lab for PHYS 1151 1 SH

PHYSICS 2
PHYS 1165 Physics 2 4 SH
with PHYS 1166 Lab for PHYS 1165 1 SH
or PHYS 1155 Physics for Engineering 2 4 SH
with PHYS 1156 Lab for PHYS 1155 1 SH

Intermediate Physics
Complete the following three courses:
PHYS 2303 Modern Physics 4 SH
PHYS 2305 Thermodynamics and Statistical Mechanics 4 SH
PHYS 2371 Electronics 4 SH

Advanced Physics
Complete the following four courses:
PHYS 3600 Advanced Physics Laboratory 1 4 SH
PHYS 3602 Electricity and Magnetism 4 SH
PHYS 3603 Electromagnetic Waves and Optics 4 SH
PHYS 5115 Quantum Mechanics 4 SH

Experiential Education
Complete the following course:
PHYS 4996 Experiential Education Directed Study 4 SH

Senior Capstone
Complete the following course:
PHYS 5318 Principles of Experimental Physics 4 SH

Engineering Undergraduate Requirements
Complete the following three courses:
EECE 2400 Linear Circuits 4 SH
EECE 2402 Electronics 4 SH
EECE 3464 Linear Systems 4 SH

Engineering Graduate Requirements
Complete the following two courses:
EECE 7200 Linear Systems Analysis 4 SH
EECE 7204 Applied Probability and Stochastic Processes 4 SH

Engineering Graduate Electives
Complete six graduate EECE courses.

EXPERIENTIAL LEARNING
Complete one course in experiential education. Please see department for approved courses.

APPLIED PHYSICS AND ENGINEERING MAJOR CREDIT REQUIREMENT
Complete 115 semester hours in the major.

GENERAL ELECTIVES
Additional courses taken beyond college and major course requirements to satisfy graduation credit requirements.

COOPERATIVE EDUCATION
If elected

UNIVERSITY-WIDE REQUIREMENTS
160 total semester hours required
Minimum 3.000 GPA required
Minor in Physics

REQUIRED COURSES
Complete one of the following sequences with corresponding labs, as indicated:

**Physics 1 and 2**

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<td>Lab for PHYS 1161</td>
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<tr>
<td>PHYS 1165</td>
<td>Physics 2</td>
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<tr>
<td>with PHYS 1166</td>
<td>Lab for PHYS 1165</td>
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**Physics for Engineering 1 and 2**

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<th>Title</th>
<th>SH</th>
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<tbody>
<tr>
<td>PHYS 1151</td>
<td>Physics for Engineering 1</td>
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<td>Lab for PHYS 1151</td>
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<td>PHYS 1155</td>
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<td>with PHYS 1156</td>
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ELECTIVE COURSES
Complete three courses from the following list:

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<tr>
<td>MATH 4606</td>
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<td>PHYS 2303</td>
<td>Modern Physics</td>
<td>4</td>
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<tr>
<td>PHYS 2305</td>
<td>Thermodynamics and Statistical Mechanics</td>
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<td>PHYS 2371</td>
<td>Electronics</td>
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<td>PHYS 3600</td>
<td>Advanced Physics Laboratory 1</td>
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<td>PHYS 3601</td>
<td>Classical Dynamics</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 3602</td>
<td>Electricity and Magnetism</td>
<td>4</td>
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<td>PHYS 3603</td>
<td>Electromagnetic Waves and Optics</td>
<td>4</td>
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<td>PHYS 4606</td>
<td>Mathematical and Computational Methods for Physics</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 4621</td>
<td>Biological Physics 1</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 4623</td>
<td>Medical Physics</td>
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</tr>
<tr>
<td>PHYS 5113</td>
<td>Introduction to Particle and Nuclear Physics</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 5260</td>
<td>Introduction to Nanoscience and Nanotechnology</td>
<td>4</td>
</tr>
</tbody>
</table>

GPA REQUIREMENT
2.000 GPA required in the minor