

## PHYSICS

[www.physics.neu.edu](http://www.physics.neu.edu)

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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. <i>Note:</i> 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
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**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
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**Senior Capstone**

Complete the following course:

PHYS 5318	Principles of Experimental Physics	4 SH
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**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
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**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 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		

**APPLIED PHYSICS MAJOR REQUIREMENTS****Introductory Physics**

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

<b>PHYSICS 1</b>		
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
<b>PHYSICS 2</b>		
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:

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	4 SH

**General Engineering**

Complete the following engineering course:

GE 1111	Engineering Problem Solving and Computation	4 SH
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**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:

<b>PHYSICS 1</b>		
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
<b>PHYSICS 2</b>		
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 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

PHYS 5113	Introduction to Particle and Nuclear Physics	4 SH
PHYS 5260	Introduction to Nanoscience and Nanotechnology	4 SH

**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
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**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

**BSCHE in Chemical Engineering and Physics**For degree requirements, please visit the myNEU Web Portal ([www.myneu.neu.edu](http://www.myneu.neu.edu)), click on the "Self-Service" tab, then on "My Degree Audit."**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
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**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
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**Senior Capstone**

Complete the following course:

PHYS 5318	Principles of Experimental Physics	4 SH
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**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*

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

#### *Physics for Engineering 1 and 2*

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

### ELECTIVE COURSES

Complete three courses from the following list:

MATH 4606	Mathematical and Computational Methods for Physics	4 SH
PHYS 2303	Modern Physics	4 SH
PHYS 2305	Thermodynamics and Statistical Mechanics	4 SH
PHYS 2371	Electronics	4 SH
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 4606	Mathematical and Computational Methods for Physics	4 SH
PHYS 4621	Biological Physics 1	4 SH
PHYS 4623	Medical Physics	4 SH
PHYS 5113	Introduction to Particle and Nuclear Physics	4 SH
PHYS 5260	Introduction to Nanoscience and Nanotechnology	4 SH

### GPA REQUIREMENT

2.000 GPA required in the minor