Physics (PHY)

Major and Minor in Physics

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Minors of particular interest to students majoring in Physics: Astronomy (AST), Computer Science (CSE), Electrical Engineering (ESE), Materials Science (ESM), Mathematics (MAT), Nanotechnology Studies (NTS), Science and Engineering (LSE)

Physics (PHY)

Physics is the study of the basic physical principles that govern our universe. This study uses the language of mathematics and is applied in all other natural sciences (astronomy, chemistry, biology, geology, etc.) and engineering. The objective of the major in Physics is to teach students those principles, and, in general, how to think scientifically about the physical world.

A basic education in physics is also applicable to many other fields, including astronomy, engineering, computer programming, geology, biophysics, medicine, medical technology, teaching, law, business, etc. Since the basic principles of physics do not go out of style, and will be the basis for many new technologies, the Physics major provides the ability to adapt to new conditions; hence its permanent value. After graduation approximately half of our Physics majors go on to graduate school, either in physics or in a related field (such as those mentioned above). The other half initially take positions in industry, but many of them later return to graduate school.

Requirements for the Major and Minor in Physics (PHY)

The major in Physics leads to the Bachelor of Science degree.

All courses used to satisfy the major requirements must be completed with a grade of C or higher, except that a maximum of three courses at the 100- or 200-level may be completed with a grade of C-.

Completion of the major requires approximately 67 credits.

A. Courses in Physics

- PHY 131/133, 132/134 Classical Physics I, II with Laboratories (See Note 1)
- PHY 251/252 Modern Physics with Laboratory
- PHY 277 Computation for Physics and Astronomy
- PHY 300 Waves and Optics
- PHY 301 Electromagnetic Theory
- PHY 303 Mechanics
- PHY 306 Thermodynamics, Kinetic Theory, and Statistical Mechanics
- PHY 308 Quantum Physics
- PHY 335 Electronics and Instrumentation Laboratory
- PHY 445 Senior Laboratory

Notes:

1. The sequence PHY 125, 126, 127 with labs PHY 133 & 134 or PHY 141/133, 142/134 may substitute for PHY 131/133, 132/134. PHY 127 may be taken before PHY 126**.**

2. At least four courses numbered 300 or above must be taken at Stony Brook.

3. AST 443 may substitute for PHY 445.

4. PHY/BME double majors who graduate with a BE in Biomedical Engineering may substitute BME 120 for PHY 277.
5. PHY/CSE double majors who graduate with a BS in Computer Science are exempt from PHY 277.

B. Courses in Mathematics

1. One of the following sequences: MAT 125, 126, 127 Calculus A, B, Cor MAT 131, 132 Calculus I, II or MAT 141, 142 Honors Calculus I, II or MAT 171 Accelerated Single Variable Calculus or AMS 151, 161 Applied Calculus I, II. If students do not place into MAT 125 or 131 on the basis of the math placement examination, MAT 123 is a required course for the major.

2. One of the following: MAT 205 Calculus III or MAT 203 Calculus III with Applications or AMS 261 Applied Calculus III

3. One of the following: MAT 305 Calculus IV or MAT 303 Calculus IV with Applications or AMS 361 Applied Calculus IV: Differential Equations

Note: Equivalency for MAT courses achieved on the Mathematics Placement Examination is accepted as fulfillment of the corresponding requirements, as indicated in the Course Descriptions section of this Bulletin.

C. Courses in Related Fields

Twelve credits of physics-related courses that complement a Physics major's education are required. The intent is to add courses, especially in other quantitative sciences, which prepare the student for successful employment in research, education or industry. Any course beyond those required for the physics major that is required by the student's minor, second major or master's degree (for students in a combined degree program) is automatically included in the list of related courses. Additional related courses are listed below, but they are not exclusive. If another course is of interest and should qualify under the above goals, consult the undergraduate program director to see if it can be included.

- **AMS:** 102, 110, 210, 301, 303, 310, 311, 315 332, 335, 345, 351 and other 300-level courses (not 361).
- **AST**: 203, 205,287, 341, 346, 347, 443, 447 and 487.
- **ATM:** 205, 247, 305, 320, 345, 346, 348, 397, 447 and 487.
- **BIO:** 201, 202, 203, 204, 205, 207, 310, 311, 332 and other 300-level courses.
- **BME:** 100, 120, 212, 212, 260 and many 300-level courses.
- **CHE:** 131/133, 132/134, 152, 154, 301, 302, 321, 322, 351, 375 and other 300-level courses.
- **CSE:** 110, 130, 150, 160, 161, 230, 260, 261 and most 300-level courses.
- **ECO:** 303, 305, 310, 321, 355 and 373.
- **ESE:** many 200- and 300-level courses.
- **ESG:** 302 and other 300-level courses.
- **ESM:** many 200- and 300-level courses.
- **EST:** 291, 320, 392, 393 and 499.
- **GEO:** 287 and many 300-level courses.
- **HBM:** 320 and 321.
- **ISE:** 332
- **MAT:** 211, 310,312, 331, 333, 341, 342, 351, 362 and many 300-level courses (not 303, 305 or 307).
- **MAR:** most 300-level courses.
- **MEC:** most 300-level courses.
- **WSE:** 187 and 242

D. Upper-Division Writing Requirement

Students are certified as satisfying the upper-division writing requirement by registering for the 0-credit PHY 459 and completing a writing project within their major. Students majoring in physics should consult an actual publication (for instance in Physical Review Letters or Physics Today) when considering the style of their submission. The writing project should be a clear, concise expression of a scientific statement. Within the first month of the semester in which the writing requirement is to be satisfied, the student should speak to the supervisor about his/her plans. If there are questions over the suitability of the proposed writing project, the student should discuss the proposal with the undergraduate program director. After the paper is accepted by the supervisor it is submitted to the undergraduate program director for a final approval. Satisfaction of the writing requirement is certified independently of the course grade, and is best completed in the junior year.

Students should consult with the department advisor to ensure that their plan for completing the Upper Division Writing Requirement is consistent with university graduation requirements for General Education. Students completing the Stony Brook Curriculum (SBC) must complete a course that satisfies the "Write Effectively within One's Discipline" (WRTD) learning objective to graduate. The Upper Division Writing Requirement is consistent in most cases with the SBC learning outcomes for WRTD.

Honors

To receive the Bachelor of Science in Physics with honors, in addition to having completed all the requirements for the B.S. in Physics, a student must satisfy the following:

1. PHY 487 Research (at least 3 credits total)
2. Two other 400-level physics courses
3. Overall grade point average of at least 3.30 in all physics courses numbered 300 or higher.

The Research Program

Students who wish to pursue graduate study in physics should choose a program similar to this suggested example:

Freshman Year

- PHY 131/133 Classical Physics I with Laboratory or PHY 141/133 Classical Physics I: Honors
- PHY 132/134 Classical Physics II with Laboratory or PHY 142/134 Classical Physics II: Honors
- MAT 131 Calculus I
- MAT 132 Calculus II

Sophomore Year

- PHY 251/252 Modern Physics with Laboratory
- PHY 277 Computation for Physics and Astronomy
- PHY 300 Waves and Optics
- MAT 205 Calculus III
- MAT 305 Calculus IV
- CHE 131, 132 General Chemistry
- CHE 133, 134 General Chemistry Laboratory

Junior Year

- PHY 301, 302 Electromagnetic Theory
- PHY 303 Mechanics
- PHY 306 Thermodynamics, Kinetic Theory, and Statistical Mechanics
- PHY 308 Quantum Physics
- PHY 335 Electronics and Instrumentation Laboratory
- MAT 211 Linear Algebra
- MAT 341 Applied Real Analysis
- MAT 342 Applied Complex Analysis

Senior Year

- PHY 405 Advanced Quantum Physics
- PHY 445 Senior Laboratory
- At least 3 credits of PHY 487 research, and one other 400 level course.

Note: Of the courses mentioned above, MAT 211, MAT 341, MAT 342, PHY 302, and 400 level courses other than PHY 445 are not required for the B.S. in Physics.

Specialization in Optics

Students majoring in Physics may decide to pursue a specialization in Optics. This specialization is listed on the official transcript.

In addition to the courses required for the major, students must complete the following with a grade of C or better to satisfy the requirements of the specialization:
A. Required Departmental Courses (6 credits)
PHY 302 Electricity and Magnetism II
PHY 452 Lasers
B. Optics-Related Laboratory Experience
PHY 487 Research (at least three credits, optics related)

C. One Additional Elective Course:
Either PHY 405 Advanced Quantum Mechanics, or one of many courses in other departments (including the College of Engineering and Applied Sciences-CEAS) that could meet the requirements for this additional elective. Advance approval of such courses must be obtained from the Director of Undergraduate Studies. Examples of such courses in the CEAS are: ESE 340 Basic Communication Theory; ESE 358 Computer Vision; ESE 363 Fiber Optic Communications; and ESM 325 Diffraction Techniques.

Physics Secondary Teacher Education Program

See the Education and Teacher Certification entry in alphabetical listings of Approved Majors, Minors, and Programs.

Introductory Physics Sequences

The Department of Physics offers four Introductory Physics Sequences. The PHY 121/123, 122/124 sequence is designed specifically for students majoring in biological sciences or pre-medical/pre-health programs. Any of the other three sequences (PHY 131/133, 132/134; PHY 141/133, 142/134; PHY 125, 126, 127 and PHY 133 & 134 together with PHY 251/252 constitute a comprehensive introduction to classical and modern physics for those who may major in Physics, other physical sciences, or engineering. These three introductory Physics sequences cover the same material, although the pace is different. The two-semester sequence (PHY 131/133, 132/134 or PHY 141/133, 142/134) should be taken only by students who are prepared for a pace considerably faster than the three semester sequence (PHY 125/126/127/133/134). The PHY 141/133/142/134 sequence is designed for students with the strongest interest and preparation in physics and mathematics. In the PHY 125/126/133/127/134 sequence, PHY 126 and 127 may be taken in either order, although 133 remains a prerequisite for 134.

Minor

The minor in Physics is available for students who want their University studies to include significant upper-division work in physics.

All courses offered for the minor must be passed with a letter grade of C or higher. Completion of the minor requires 20 physics credits beyond the Introductory Physics Sequence.

Requirements for the Minor in Physics for students with majors in the College of Arts and Sciences:

- PHY 251/252 Modern Physics
- PHY 300 Waves and Optics
- PHY 301 Electromagnetic Theory
- PHY 303 Mechanics
- PHY 335 Electronics and Instrumentation Laboratory
- One of the following:
- PHY 306 Thermodynamics, Kinetic Theory, and Statistical Mechanics
- CHE 302 Physical Chemistry II

Requirements for the Minor in Physics for students with majors in the College of Engineering and Applied Sciences:

- One of the following:
  - PHY 251/252 Modern Physics
  - ESG 281 An Engineering Introduction to the Solid State
- PHY 300 Waves and Optics
- One of the following:
  - PHY 300 Waves and Optics
  - ESG 281 An Engineering Introduction to the Solid State
- One of the following:
  - PHY 301 Electromagnetic Theory
  - ESE 319 Introduction to Electromagnetic Fields and Waves
  - PHY 303 Mechanics
- One of the following:
  - PHY 306 Thermodynamics, Kinetic Theory, and Statistical Mechanics
  - MEC 398 Thermodynamics II
- One of the following:
  - PHY 335 Electronics and Instrumentation Laboratory
  - ESE 314 Electronics Laboratory B

Sample Course Sequence for the Major in Physics
A course planning guide for this major may be found here.

FRESHMAN

FALL	Credits
First Year Seminar 101	1
WRT 101	3
MAT 131	4
PHY 131/PHY 133	4
SBC	3
Total	15

SPRING	Credits
First Year Seminar 102	1
WRT 102	3
MAT 132	4
PHY 132/PHY 134	4
SBC	3
Total	15

SOPHOMORE

FALL	Credits
PHY 251/PHY 252	4
PHY 277	3
MAT 205	3
SBC	3
SBC	3
Total	16

SPRING	Credits
PHY 300	4
MAT 305	3
SBC	3
SBC	3
SBC	3
Total	16

JUNIOR

FALL	Credits
PHY 301	3
PHY 303	3
PHY-related elective	3
MAT 211 or MAT 341	3
SBC	3
Total	15

SPRING	Credits
PHY 306	3
PHY 308	3
PHY 335	3
MAT 211 or MAT 342	3
SBC	3
Total	15

SENIOR

FALL	Credits
PHY 487	3
PHY elective	3
PHY-related elective	3
Upper-division SBC	3
Upper-division SBC	3
Total	15

SPRING	Credits

PHY 445	3
PHY elective	3
PHY-related elective	3
PHY-related elective	3
Upper-division SBC	3
Total	15

PHY

Physics

PHY 100: Physics Head Start

An intensive review of the physics and associated mathematical tools necessary to solve the problems and do the calculations encountered in the introductory physics courses. The emphasis will be on the application of trigonometry to physical problems, the manipulation of vectors, diagramming and graphing, and algebraic manipulation including solving linear equations with more than one variable. The use of derivatives to describe physical quantities will be touched on and integrals will be motivated.

Prerequisite: MAT 123 or level 4 on the math placement exam

2 credits, S/U grading

PHY 112: Light, Color, and Vision

An introduction to the modern understanding of light, color, and vision, primarily for non-science majors and especially beneficial to students majoring in visual arts or theatre. Topics include the nature of light; the human eye and vision; illusions, color perception, and color theory; optical instruments; the camera and photography; optical phenomena in the atmosphere (mirages, rainbows, halos); and light in modern physics (relativity, lasers). Not for major credit. Not for credit in addition to PHY 122, PHY 126, PHY 132 or PHY 142.

Prerequisite: Satisfaction of entry skill in mathematics requirement (Skill 1) or satisfactory completion of D.E.C. C or QPS

DEC: *E*
SBC: *SNW*

3 credits

PHY 113: Physics of Sports

First part of an introduction to physics from the perspective of sports, especially designed for non-science majors. Basic concepts in classical mechanics and fluid dynamics are used to analyze particular actions in football, baseball, soccer, track and field, and other sports. Students learn, for example, about the knuckle ball in baseball and why it is so hard to hit, and why quarterbacks throw a football in a spiral. The concepts of heat, energy, and calories are also discussed. The laboratory component, PHY 115, may be taken concurrently with or after PHY 113. Not for credit in addition to PHY 121, PHY 125, PHY 131 or PHY 141.

Prerequisite: Satisfaction of entry skill in mathematics requirement (Skill 1) or satisfactory completion of D.E.C. C or QPS

DEC: *E*
SBC: *SNW*

3 credits

PHY 114: Electromagnetism, Waves and Radiation for Sports Science

Second part of the Physics of Sports sequence. The focus is on electricity, magnetism, optics, acoustics, radiation, and medical imaging. The laboratory component, PHY 116, may be taken concurrently with or after PHY114.

Prerequisite: PHY 113

DEC: *E*
SBC: *SNW*

3 credits

PHY 115: Physics of Sports Laboratory

Laboratory component of PHY 113. Experiments are designed to help students better understand the physics aspects of sports. Students work in groups and conduct experiments indoors and outdoors. Knowledge of first-year college-level mathematics is recommended, but most necessary information is taught in class as needed. May be taken concurrently with or after PHY 113.

Pre or Corequisite: PHY 113

1 credit

PHY 116: Electromagnetism, Waves and Radiation for Sports Science Laboratory

Laboratory component of PHY 114. Experiments are designed to help students better understand the physics aspects of sports. Knowledge of first-year college-level mathematics is recommended, but most necessary information is taught in class as needed. May be taken concurrently with or after PHY 114.

Prerequisites: PHY 113 and 115
Pre- or Corequisite: PHY 114

1 credit

PHY 119: Physics for Environmental Studies

The principles of physics as they apply to environmental issues. A review of mathematics is followed by a discussion of Newton's laws, conservation principles, topics in fluids and wave motion, optical instruments, and radioactivity. Three lectures and one laboratory session per week. This course is offered as both ENS 119 and PHY 119.

Prerequisites: MAT 123; CHE 131

DEC: *E*
SBC: *SNW*

4 credits

PHY 121: Physics for the Life Sciences I

First part of an introduction to physics with applications to biology, primarily for students majoring in biological sciences or pre-clinical programs. Topics include mechanics, fluid mechanics, and thermodynamics. Strong algebra skills and knowledge of the ideas of calculus are required. Three lecture hours per week. The Laboratory component, PHY 123, must be taken concurrently; a common grade for both courses will be assigned. PHY 121 may not be taken for credit in addition to PHY 125, 131, or 141. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisites: MAT 125 or 131 or 141 or AMS 151
Corequisite: PHY 123

DEC: *E*
SBC: *SNW*

3 credits

PHY 122: Physics for the Life Sciences II

Second part of an introduction to physics with applications to biology, primarily for students majoring in biological sciences or pre-clinical programs. Topics include electromagnetism, optics, acoustics, and radiation phenomena. Strong algebra skills and knowledge of the ideas of calculus are required. Three lecture hours per week. The Laboratory component, PHY 124, must be taken concurrently; a common grade for both courses will be assigned. PHY 122 may not be taken for credit in addition to PHY 126, 127, 132, or 142. This course has been designated as a High Demand/ Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: C or higher in PHY 121/123
Corequisite: PHY 124; CHE 132

DEC: *E*
SBC: *SNW*

3 credits

PHY 123: Physics for Life Sciences Laboratory I

Must be taken concurrently with Lecture component, PHY 121; a common grade for both courses will be assigned. Two hours of laboratory per week. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have

priority to do so. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.

Corequisite: PHY 121

1 credit

PHY 124: Physics for Life Sciences Laboratory II

Must be taken concurrently with Lecture component, PHY 122; a common grade for both courses will be assigned. Two hours of laboratory per week. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.

Prerequisite: C or higher in PHY 121/123
Corequisite: PHY 122

1 credit

PHY 125: Classical Physics A

First of a three-part sequence intended for physical-sciences or engineering majors. It focuses on the mechanics of point particles and simple oscillators, and emphasizes motion in one and two dimensions and the concepts of momentum and energy. Calculus is used concurrently with its development in MAT 125. Three lecture hours and one recitation hour per week. Not for credit in addition to PHY 121/123, PHY 131, or PHY 141. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: MAT 123 or Level 4 on the mathematics placement examination
Corequisite: MAT 125 or MAT 131 or MAT 141 or AMS 151

DEC: *E*
SBC: *SNW*

4 credits

PHY 126: Classical Physics B

Second or third of a three-part sequence for physical-sciences or engineering majors. It focuses on the mechanics of rigid bodies, on fluids, waves, thermodynamics, and optics. Three lecture hours and one recitation hour per week. Associated Labs (PHY 133 or PHY 134) are offered separately. Not for credit in addition to PHY 122/PHY 124, PHY 132, or PHY 142. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: C or higher: PHY 125 or 131 or 141 Corequisite: MAT 126, 132, 142, 171 or AMS 161 or level 7 or higher on math placement exam

DEC: *E*
SBC: *SNW*

3 credits

PHY 127: Classical Physics C

Second or third of a three-part sequence for physical-sciences or engineering majors. It focuses on electromagnetism using the concepts of vector fields and scalar potentials, and on DC and AC electric circuits. Calculus is used concurrently with its development in MAT 126. Three lecture hours and one recitation hour per week. Associated Labs (PHY 133 or PHY 134) are offered separately. Not for credit in addition to PHY 122/PHY 124, PHY 132, or PHY 142. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: C or higher: PHY 125 or 131 or 141 Corequisite: MAT 126, 132, 142, 171 or AMS 161 or level 7 or higher on math placement exam

DEC: *E*
SBC: *SNW*

3 credits

PHY 131: Classical Physics I

First part of a two-semester physics sequence for physical-sciences or engineering majors who have a strong mathematics background and are ready for a fast learning pace. It covers mechanics, wave motion, kinetic theory, and thermodynamics. Calculus is used concurrently with its development in MAT 131. Three lecture hours and one recitation hour per week. The Laboratory component, PHY 133 (Lab 1), could be taken concurrently. Not for credit in addition to PHY 121/123, PHY 125, or PHY 141. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: MAT 123 or level 5 on the mathematics placement examination
Corequisite: MAT 125 or MAT 131 or MAT 141 or AMS 151

DEC: *E*
SBC: *SNW*

3 credits

PHY 132: Classical Physics II

Second part of a two-semester physics sequence for physical-sciences or engineering majors who have a strong mathematics background and are ready for a fast learning pace. It covers electromagnetism, electric circuit theory, and optics. Calculus is used concurrently with its development in MAT 132. Three lecture hours and one recitation hour per week. The Laboratory component, PHY 134, may be taken concurrently. Not for credit in addition to PHY 122/124, PHY 126, PHY 127, or PHY 142. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.

Prerequisite: C or higher in PHY 131 or PHY 141
Corequisite: MAT 132 or MAT 142 or MAT 127 or MAT 171 or AMS 161

DEC: *E*
SBC: *SNW*

3 credits

PHY 133: Classical Physics Laboratory I

Two hours of laboratory per week that corresponds to the content of PHY 131 or PHY 125+PHY 126. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.

Prerequisite: C or higher in PHY 125; or pre- or corequisite PHY126 or PHY 131; or corequisite PHY 141

1 credit

PHY 134: Classical Physics Laboratory II

Two hours of laboratory per week that corresponds to the content of PHY 132 or PHY 126+127. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so. This course has an associated fee. Please see www.stonybrook.edu/coursefees for more information.

Prerequisite: C or higher in PHY 133
Pre- or Corequisite: PHY 126 and PHY 127; or PHY 132; or corequisite PHY 142

1 credit

PHY 141: Classical Physics I: Honors

First part of a demanding two-semester sequence for students with the strongest background, interests, and abilities in science and mathematics. The topics covered in PHY 141 are similar to those in PHY 131 but are treated in more depth in a small-class setting. Students may transfer to PHY 131 at any time

during the first half of each semester without penalty. Three lecture hours and one recitation hour per week. PHY 141 may not be taken for credit in addition to PHY 121/123, PHY 125, or PHY 131.

Prerequisite: Level 6 on Math Placement, or B or higher in MAT 131 or 141 or AMS 151, or B+ or higher in MAT 125, or instructor permission (priority given to students in Honors or WISE programs)
Corequisite: MAT 131 or 141 or 126 or AMS 151; PHY 133

DEC: *E*
SBC: *SNW*

3 credits

PHY 142: Classical Physics II: Honors

Second part of a demanding two-semester sequence for students with the strongest background, interests and abilities in science and mathematics. The topics covered in PHY 142 are similar to those in PHY 132, but are treated in more depth in a small-class setting. Students may transfer to PHY 132 at any time during the first half of each semester without penalty. Three lecture hours and one recitation hour per week. PHY 142 may not be taken for credit in addition to PHY 122/124, PHY 126, PHY 127, or PHY 132.

Prerequisite: C or higher in PHY 141 or permission of department
Corequisite: MAT 132 or 142 or 127 or 171 or AMS 161; PHY 134

DEC: *E*
SBC: *SNW*

3 credits

PHY 191: Transitional Study

Laboratory for transfer students to supplement courses taken at another institution. Students take the laboratory portion of a 100-level course for which they have taken the theoretical portion elsewhere.

Prerequisite: Permission of department

1 credit

PHY 192: Transitional Study

Laboratory for transfer students to supplement courses taken at another institution. Students take the laboratory portion of a 100-level course for which they have taken the theoretical portion elsewhere.

Prerequisite: Permission of department

1 credit

PHY 231: Physics for Future Presidents

A study of key physics ideas that a newly-inaugurated President of the country, or a newly-hired President of a company, needs to know. This course equips the future President with enough knowledge of the physics behind a pressing issue to make an intelligent decision even in the face of conflicting advice about issues including energy, national security, and space exploration. Politics is the art of balancing competing demands, and business involves profitably serving customers, so the economics of many technologies will also be discussed.

Prerequisite: one D.E.C. E or SNW course and one D.E.C. F or SBS course

SBC: *STAS*

3 credits

PHY 237: Current Topics in World Climate and Atmosphere

An exploration of current concerns about the greenhouse effect, acid rain, and global ozone loss, in a format accessible to non-science majors. The social and political steps being taken to limit global atmospheric pollution and climate change are discussed. Not for major credit. This course is offered as both ATM 237 and PHY 237.

Prerequisite: one D.E.C. E or SNW course; satisfaction of entry skill in mathematics requirement or level 2+ on the mathematics placement examination

DEC: *H*
SBC: *STAS*

3 credits

PHY 251: Modern Physics

A survey of the major physics theories of the 20th century (relativity and quantum mechanics) and their impact on most areas of physics. It introduces the special theory of relativity, the concepts of quantum and wave-particle duality, Schroedinger's wave equation, and other fundamentals of quantum theory as they apply to nuclei, atoms, molecules, and solids. The Laboratory component, PHY 252, must be taken concurrently; a common grade for both courses will be assigned. Three hours lecture and one hour recitation per week.

Prerequisite: PHY 122/124, or PHY 126 and 127, or PHY 132 or PHY 142; and PHY 134; C or higher in MAT 126 or 132 or 142 or 171 or AMS 161 Pre- or Corequisite: MAT 203 or MAT 205 or AMS 261 or MAT 307
Corequisite: PHY 252

SBC: *STEM+*

3 credits

PHY 252: Modern Physics Laboratory

Must be taken concurrently with lecture component PHY 251; a common grade for both courses will be assigned. Students perform some of the pivotal experiments of the 20th century. The Lecture component, PHY 251, must be taken concurrently; a common grade for both courses will be assigned. Two hours of laboratory per week.

Corequisite: PHY 251

1 credit

PHY 277: Computation for Physics and Astronomy

An introduction to computing on UNIX/ Linux computers. Fundamentals of using UNIX/Linux to write computer programs for numerical algorithms to solve computational physics and astronomy problems. Assignments are carried out in a high-level compiler programming language such as Fortran 90 or C++ and require extensive use of SINC site computers outside the classroom.

Prerequisite: PHY 125, PHY 126, PHY 127 and PHY 133 &, PHY 134; or PHY 131/133, PHY 132/134; or PHY 141/133, PHY 142/134; AMS 151 or MAT 126 or MAT 131 or MAT 141
Advisory Prerequisite: AMS 161 or MAT 127 or MAT 132 or MAT 142 or MAT 171

SBC: *TECH*

3 credits

PHY 287: Introduction to Research

An opportunity for students, while still early in their studies, to do research commensurate with their level of preparation. Students work alongside faculty, post-doctoral fellows, and graduate students on ongoing research projects. Students must take the initiative to negotiate the opportunity. BNL and other scientists may be allowed as co-supervisors. May be repeated up to a total of 3 credits.

Prerequisite: Permission of department

SBC: *EXP+*

0-3 credits

PHY 291: Transitional Study

A laboratory for transfer students to supplement a course taken at another institution. Students take the laboratory portion of a 200-level course for which they have taken the theoretical portion elsewhere.

Prerequisite: Permission of department

1 credit

PHY 300: Waves and Optics

The physics of oscillations and waves, from mechanical waves to light waves to electron waves. Topics include resonance and normal modes of coupled oscillators, the wave equation and wave propagation, interference and diffraction, polarization and imaging, coherence, and lasers. Three lecture hours and one three-hour laboratory per week.

Prerequisite: PHY 132/PHY 134 or PHY 142/ PHY 134 or PHY 126/PHY 127/PHY 134
Corequisite: MAT 203 or MAT 205 or AMS 261

SBC: *STEM+*

4 credits

PHY 301: Electromagnetic Theory I

The application of Maxwell's equations to solve time-independent boundary-value problems and to study the interactions of electric and magnetic fields with bulk matter.

Prerequisite: PHY 251 and PHY 277 or permission of department; MAT 203 or MAT 205 or AMS 261
Advisory Corequisite: MAT 341

3 credits

PHY 302: Electromagnetic Theory II

A study of time-dependent electric and magnetic fields as derived from Maxwell's equations. Topics include the interrelations of electric and magnetic fields and their potentials; energy and momentum associated with electromagnetic fields and the Maxwell vacuum and matter; waveguides and transmission lines; special relativity for electromagnetism; retarded potentials for time-varying sources; and radiation of electromagnetic waves.

Prerequisite: PHY 301

3 credits

PHY 303: Mechanics

An in-depth study of classical mechanics, from the Newtonian to the Lagrangian and Hamiltonian formulations. First, Newtonian mechanics is reviewed and applied to more advanced problems than those considered in PHY 131 or 141. The Lagrangian and Hamiltonian methods are then derived from the Newtonian treatment and applied to various problems.

Prerequisite: PHY 251 and PHY 277 or permission of department; MAT 303 or MAT 305 or AMS 361

3 credits

PHY 306: Thermodynamics, Kinetic Theory, and Statistical Mechanics

A study of the laws that govern physical systems in thermal equilibrium. In the first part, the concepts of temperature, internal energy, and entropy are analyzed and the first and second laws of thermodynamics are used to connect various properties that are independent of the microscopic details of the system. The second part is devoted to a microscopic study of a system in thermal equilibrium, from the kinetic theory of gases to statistical mechanics and the relation between entropy and probability, with application to simple examples in classical and quantum statistics.

Prerequisites: PHY 251, 277, 300

3 credits

PHY 307: Physical and Mathematical Foundations of Quantum Mechanics

Physical and mathematical foundations of quantum mechanics. Maxwell waves and their properties: intensity, energy density, and momentum density. Planck-Einstein relation between energy and frequency for light quanta. De Broglie relation between momentum and wavelength. Number density and probability density of photons. One-photon quantum mechanics, with Maxwell field as the wave function. Diffraction phenomena. Uncertainty relation between wavelength and position, hence between momentum and position. Not for credit in addition to PHY 390 with similar topic. Not for credit in addition to PHY 274.

Prerequisites: PHY 122/124, or PHY 126 and PHY 127 and PHY 134, or PHY 132 and PHY 134, or PHY 142 and PHY 134; MAT 132 or MAT 142 or MAT 127 or MAT 171 or AMS 161
Advisory Corequisite: MAT 203 or MAT 205 or AMS 261

4 credits

PHY 308: Quantum Physics

The concepts, historical development, and mathematical methods of quantum mechanics. Topics include Schroedinger's equation in time-dependent and time-independent forms; one- and three-dimensional solutions, including the treatment of angular momentum and spin. Applications to simple systems, especially the hydrogen atom, are stressed.

Prerequisite: PHY 300, 301, and 303

3 credits

PHY 311: Connections in Science

A selection of the interrelations between physics and other scientific and technological fields, using modern examples from engineering, medicine, and applied mathematics, among others. The course is taught as a seminar and includes guest lecturers, tours of laboratories, and discussion of classic and current research projects. Appropriate for physics and non-physics majors alike.

Prerequisite: PHY 122/124 or PHY 126 and PHY 127 and PHY 134 or PHY 132/134 or PHY 142/134

1 credit

PHY 313: Mystery of Matter

Exploration of our understanding of the basic constituents of matter, and of how that understanding and the tools developed to study them affect aspects of contemporary society. Historical discoveries and their place in social and political institutions of the time are considered, along with issues of government funding and the cost to society. Includes a discussion of developments at Brookhaven National Laboratory and their scientific and social impact. Not intended for Physics majors with U3 or U4 status.

Prerequisite: U3 or U4 standing for non-physics majors; one D.E.C. E or SNW course. All Physics/Astronomy majors need permission of department to enroll, please consult the Director of UG Studies.

DEC: *H*
SBC: *STAS*

3 credits

PHY 335: Electronics and Instrumentation Laboratory

Students will design, build and test basic DC and AC circuits which perform a useful function, as viewed by physicists, involving resistors, capacitors, transformers, diodes, transistors and operational amplifiers. Students will measure these circuits using digital multi-meters and digital oscilloscopes. Understanding of analog circuits will be stressed including negative feedback applied to operational amplifiers. Two three-hour laboratories per week.

Prerequisite: PHY 251

SBC: *TECH*

3 credits

PHY 382: The Quantum Moment: Quantum Mechanics in Philosophy, Culture, and Life (III)

This course explores the implications and influence, real and alleged, of quantum mechanics on fields other than physics. What does quantum mechanics mean, if anything, for philosophy, ethics, and social behavior? At the same time, we shall look into how social and cultural influences may have affected the way that quantum mechanics was formulated, and how it has evolved. We shall review the early history of quantum mechanics, and discuss some of the important debates at the founding of quantum mechanics. Students will not be expected to learn the mathematics in depth, only the introduction provided by the instructors aimed at non-science students. Besides readings, the course will also involve plays, films, and guest speakers. Students will be expected to work on a final project, to be presented in class. This course is offered as both PHI 382 and PHY 382.

Prerequisite: one Physics or Philosophy course and U3 or U4 standing

DEC: *H*
SBC: *STAS*

3 credits

PHY 390: Special Topics in Physics

May be repeated once as the topic changes.

Prerequisite: Permission of department

3 credits

PHY 405: Advanced Quantum Physics

Study of quantitative methods of quantum mechanics, including perturbation theory and the WKB approximation, scattering theory, and elements of quantum-information theory. Symmetry principles are stressed and advanced mathematical techniques are used throughout the course.

Prerequisite: PHY 303 and PHY 308; MAT 341

3 credits

PHY 408: Relativity

A development of the special theory of relativity leading to general relativity with applications to cosmology.

Prerequisite: PHY 302 and 303

3 credits

PHY 420: Introduction to Accelerator Science and Technology

This course will introduce students to the field of accelerator science and technology, a very versatile branch of physics and technology. This course is composed of the following parts: introduction of accelerator history and their basic principles, basic beam dynamics in synchrotrons, introduction of challenges in Accelerator physics, and introduction of typical beam measurements and instrumentations.

Prerequisite: PHY 277, PHY 300, PHY 301, PHY 302, and PHY 303
Pre- or corequisite: PHY 335

3 credits

PHY 431: Nuclear and Particle Physics

Students will study a selection of topics from the properties of elementary particles, the strong, weak, and electromagnetic forces, symmetries, particle interaction and decay rates, nuclear structure, nuclear reactions, nuclear forces, the interaction of radiation with matter, accelerators and radiation detectors.

Prerequisite: PHY 308

3 credits

PHY 445: Senior Laboratory

A selection of historically important experiments from atomic and nuclear spectroscopy, particle physics, solid-state and low-temperature physics performed with modern instrumentation. Each student does three experiments, usually with a partner. As students progress, they are encouraged to pursue independent projects, without rigid formats or procedures. The emphasis is on the development of experimental skills and on individual, ethical, professionally acceptable analysis and presentation of results, both orally and in writing. Two three-hour laboratory sessions per week.

Prerequisite: PHY 308 and PHY 335

SBC: *ESI, SPK*

3 credits

PHY 447: Tutorial in Advanced Topics

Selected readings in advanced topics for upper-division students of unusual ability and substantial accomplishments. Prior to the beginning of the semester, the topic to be studied is selected by the supervising member of the faculty and a reading assignment is planned. Weekly conferences with this faculty member are devoted to discussion of material, resolution of problems encountered, and assessment of the student's progress. May be repeated up to a total of 6 credits.

Prerequisite: Permission of department

1-6 credits

PHY 451: Quantum Electronics

Introduction to modern atomic physics for the laser era. Emphasis on the interaction between atoms and light, as well as on atomic structure and how it affects this interaction. Modern applications such as laser cooling, atom trapping, precision spectroscopy with frequency comb, quantum information, and others will be discussed.

Pre- or corequisite: PHY 405

3 credits

PHY 452: Lasers

Introduction to the theory of lasers using elementary quantum mechanics. It includes a study of resonance conditions, normal modes, and optical cavities; a description of the various types of lasers, their methods of control and their limitations; and an introduction to their applications to research, medicine, communication, and computing.

Prerequisites: PHY 300 and PHY 308

SBC: *TECH*

3 credits

PHY 459: Write Effectively in Physics

A zero credit course that may be taken in conjunction with any 300- or 400-level PHY course, with permission of the instructor. The course provides opportunity to practice the skills and techniques of effective academic writing and satisfies the learning outcomes of the Stony Brook Curriculum's WRTD learning objective.

Prerequisite: WRT 102; permission of the instructor

SBC: *WRTD*

S/U grading

PHY 472: Solid-State Physics

A study of the different types of solids, with emphasis on their thermal, electrical, and optical properties. It introduces the concepts of phonons and electronic bands, and applications to metals, semiconductors, superconductors, and magnetism.

Prerequisite: PHY 306 and 308

3 credits

PHY 475: Undergraduate Teaching Practicum

An opportunity for selected undergraduates to collaborate with the faculty in teaching at the introductory level. In addition to working as tutors and as laboratory assistants, students meet once a week with a faculty supervisor to discuss problems they have encountered and to plan future activities. Students are generally assigned to assist in courses they have completed and in which they have excelled. Not for major credit. Can be repeated up to a maximum of 6 credits with a maximum of 3 credits per course taught.

Prerequisite: Permission of department

SBC: *EXP+*

0-3 credits, S/U grading

PHY 487: Research

An opportunity for students to conduct faculty-supervised research for academic credit. Students must take the initiative to negotiate the opportunity. BNL and other scientists may be allowed as co-supervisors. Research proposals must be prepared by the student and submitted for approval by the supervising faculty before the beginning of the credit period. An account of the work and the results achieved is submitted to the supervisor before the end of the credit period. May be repeated, up to a total of 6 credits.

Prerequisite: Permission of department

SBC: *EXP+*

0-6 credits