

# PHYSICS (PHYS-SHU)

## PHYS-SHU 11 General Physics I (3 Credits)

*Typically offered occasionally*

This is an introductory physics course covering primarily mechanics and thermodynamics. The mechanics component will cover Motion along a Straight Line, Motion in Two and Three Dimensions, Newton's laws of motion, Forces, Kinetic Energy and Work, Potential Energy and Conservation of Energy, Center of Mass and Linear Momentum. The thermodynamics component will cover Temperature, Heat, and the First Law of Thermodynamics, The Kinetic Theory of Gases, Entropy and the Second Law of Thermodynamics. In addition, some introduction to the foundations of physics such as vectors and measurement will be given. In addition to the course material, the students will do open-ended research projects that encourage creative applications of physics concepts. Pre-req OR Co-req: MATH-SHU 131 Calculus or MATH-SHU 201 Honors Calculus. Anti-Requisite: Students who have taken PHYS-SHU 91 Physics I Honors with grade of C or above are not eligible. Fulfillment: CORE ED; Biology Foundational Courses; Chemistry Foundational Courses; Mathematics Science Lecture sections; Honors Mathematics Science Lecture sections; Neural Science Foundational Courses; Physics Foundational Courses; Computer Systems Engineering Prerequisite Science; Electrical Systems Engineering Prerequisite Science.

**Grading:** Ugrd Shanghai Graded

**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Biology Foundation
- SB Crse Attr: NYU Shanghai: Chemistry Foundational
- SB Crse Attr: NYU Shanghai: Computer Systems Engineering Core Sci Requirement
- SB Crse Attr: NYU Shanghai: Electrical Systems Engineering Core Science Req
- SB Crse Attr: NYU Shanghai: Experimental Discovery in the Natural World
- SB Crse Attr: NYU Shanghai: Honors Mathematics Math and Science Requirements
- SB Crse Attr: NYU Shanghai: Mathematics Math and Science Requirements
- SB Crse Attr: NYU Shanghai: Neural Science Foundational Course
- SB Crse Attr: NYU Shanghai: Physics Foundational Course

## PHYS-SHU 12 General Physics II (3 Credits)

*Typically offered Spring*

This course is an introduction to electricity and magnetism, light, geometrical and wave optics. Many concepts from General Physics I will be used in this course such as velocity, acceleration, force, Newton's laws of motion, work and energy. The course uses high school algebra, geometry and trigonometry, vectors and vector arithmetic, and some basic calculus. The algebra, geometry, and trig are essential. The course has lecture, homework and laboratory components. Prerequisite: General Physics I (PHYS-SHU 11). Anti-Requisite: Students who have taken PHYS-SHU 93 Physics II Honors with grade of C or above are not eligible. Fulfillment: Biology Foundational Courses; Chemistry Foundational Courses; Mathematics Science Lecture sections; Honors Mathematics Science Lecture sections; Neural Science Foundational Courses; Computer Systems Engineering Prerequisite Science; Electrical Systems Engineering Prerequisite Science.

**Grading:** Ugrd Shanghai Graded

**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Biology Foundation
- SB Crse Attr: NYU Shanghai: Chemistry Foundational
- SB Crse Attr: NYU Shanghai: Computer Systems Engineering Core Sci Requirement
- SB Crse Attr: NYU Shanghai: Electrical Systems Engineering Core Science Req
- SB Crse Attr: NYU Shanghai: Honors Mathematics Math and Science Requirements
- SB Crse Attr: NYU Shanghai: Mathematics Math and Science Requirements
- SB Crse Attr: NYU Shanghai: Neural Science Foundational Course

## PHYS-SHU 71 Foundations of Physics Lab I (2 Credits)

*Typically offered Fall*

This laboratory course is to accompany FoS physics lecture. Students will be familiarized with various techniques, equipment, data analysis skills, and ideas common to physics laboratories. Experiments in mechanics and thermodynamics are chosen to illustrate the experimental foundation of physics presented in the lecture courses. The laboratory will also emphasize scientific writing. Re-req OR Co-req: Physics I OR Found of Physics Honors I Fulfillment: CORE ED; Biology Foundational Courses; Chemistry Foundational Courses; Mathematics Science Lab sections; Honors Mathematics Science Lab sections; Neural Science Foundational Courses; Physics Foundational Courses.

**Grading:** Ugrd Shanghai Graded

**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Biology Foundation
- SB Crse Attr: NYU Shanghai: Chemistry Foundational
- SB Crse Attr: NYU Shanghai: Experimental Discovery in the Natural World
- SB Crse Attr: NYU Shanghai: Honors Mathematics Math and Science Requirements
- SB Crse Attr: NYU Shanghai: Mathematics Math and Science Requirements
- SB Crse Attr: NYU Shanghai: Neural Science Foundational Course
- SB Crse Attr: NYU Shanghai: Physics Foundational Course

**PHYS-SHU 91 Foundations of Physics I Honors (3 Credits)***Typically offered Fall*

Measurement, Motion Along a Straight Line, Vectors, Motion in Two and Three Dimensions, Force and Motion, Kinetic Energy and Work, Potential Energy and Conservation of Energy, Center of Mass and Linear Momentum, Torque and Angular Momentum, Rotation and Rigid-Body Motion, Gravitation, Equilibrium, Stability, Elasticity, Oscillations and Harmonic Motion, Special Relativity. Textbook: Young and Freedman, Sears and Zemansky's University Physics with Modern Physics, 14th Edition. Additional (optional) reading: Halliday, Resnick & Walker, Fundamentals of Physics, Extended, 10th edition. R. P. Feynman, R. B. Leighton, & M. Sands, The Feynman Lectures on Physics, Vol. 1. Pre-req OR Co-req: MATH-SHU 131 Calculus or MATH-SHU 201 Honors Calculus. Anti-Requisite: PHYS-SHU 11 General Physics. Fulfillment: CORE ED; Biology Foundational Courses; Chemistry Foundational Courses; Mathematics Science Lecture sections; Honors Mathematics Science Lecture sections; Neural Science Foundational Courses; Physics Foundational Courses; Computer Systems Engineering Prerequisite Science; Electrical Systems Engineering Prerequisite Science.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Biology Foundation
- SB Crse Attr. NYU Shanghai: Chemistry Foundational
- SB Crse Attr. NYU Shanghai: Computer Systems Engineering Core Sci Requirement
- SB Crse Attr. NYU Shanghai: Electrical Systems Engineering Core Science Req
- SB Crse Attr. NYU Shanghai: Experimental Discovery in the Natural World
- SB Crse Attr. NYU Shanghai: Honors Mathematics Math and Science Requirements
- SB Crse Attr. NYU Shanghai: Mathematics Math and Science Requirements
- SB Crse Attr. NYU Shanghai: Neural Science Foundational Course
- SB Crse Attr. NYU Shanghai: Physics Foundational Course

**PHYS-SHU 93 Foundations of Physics II Honors (3 Credits)***Typically offered Spring*

Continuation of Foundation of Physics I. Topics include electric charge and electric field, electric potential, Gauss's law, capacitor, current, circuits, magnetic fields, induction, electromagnetic waves, and Maxwell's equations (in an integral form). This is the second semester of a four-semester calculus-based introduction to Physics, and is intended for physics majors and other interested students. Prerequisite: Foundation of Physics I Honors (PHYS-SHU 91), Freshman Math (including linear algebra, vectors, linear vector spaces and matrices, functions of several variables, partial derivatives, multiple integrals) Textbook: Young and Freedman, Sears and Zemansky's University Physics with Modern Physics, 14th Edition. Prerequisite: (MATH-SHU 121 or MATH-SHU 201) and PHYS-SHU 91 Anti-Requisite: PHYS-SHU 12 General Physics II. Fulfillment: Biology Foundational Courses; Chemistry Foundational Courses; Mathematics Science Lecture sections; Honors Mathematics Science Lecture sections; Neural Science Foundational Courses; Physics Foundational Courses; Computer Systems Engineering Prerequisite Science; Electrical Systems Engineering Prerequisite Science.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Biology Foundation
- SB Crse Attr. NYU Shanghai: Chemistry Foundational
- SB Crse Attr. NYU Shanghai: Computer Systems Engineering Core Sci Requirement
- SB Crse Attr. NYU Shanghai: Electrical Systems Engineering Core Science Req
- SB Crse Attr. NYU Shanghai: Honors Mathematics Math and Science Requirements
- SB Crse Attr. NYU Shanghai: Mathematics Math and Science Requirements
- SB Crse Attr. NYU Shanghai: Neural Science Foundational Course
- SB Crse Attr. NYU Shanghai: Physics Foundational Course

**PHYS-SHU 94 Foundations of Physics Lab II (2 Credits)***Typically offered Spring*

This laboratory course is to accompany Physics II lecture PHYS-SHU 93. Experiments in electricity and magnetism, and optics are chosen to illustrate the experimental foundations of physics presented in the lecture courses. The laboratory will also emphasize scientific writing. Prerequisite/ Corequisite: General Physics II or Found of Physics II Honors. Fulfillment: Biology Foundational Courses; Chemistry Foundational Courses; Mathematics Science Lecture sections; Honors Mathematics Science Lecture sections; Neural Science Foundational Courses; Physics Foundational Courses; Computer Systems Engineering Prerequisite Science; Electrical Systems Engineering Prerequisite Science.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Biology Foundation
- SB Crse Attr. NYU Shanghai: Chemistry Foundational
- SB Crse Attr. NYU Shanghai: Computer Systems Engineering Core Sci Requirement
- SB Crse Attr. NYU Shanghai: Electrical Systems Engineering Core Science Req
- SB Crse Attr. NYU Shanghai: Honors Mathematics Math and Science Requirements
- SB Crse Attr. NYU Shanghai: Mathematics Math and Science Requirements
- SB Crse Attr. NYU Shanghai: Neural Science Foundational Course
- SB Crse Attr. NYU Shanghai: Physics Foundational Course

**PHYS-SHU 95 Foundations of Physics III Honors (3 Credits)***Typically offered Fall*

Continuation of Foundation of Physics II. Topics include thermodynamics, kinetic theory, statistical physics, wave motion, sound, reflection, refraction, interference, diffraction, polarization of light. This is the third semester of a four-semester calculus-based introduction to Physics, and is intended for physics majors and other interested students. The lectures serve as an introduction, and the real work of learning starts when you do the homework and recitation. The lectures will be most useful to you if you ask questions when there is something you do not understand. Do not imagine that you are the only person in the room who does not understand something. The most important part of the class is the homework you do. You learn more physics by doing the homework and recitation than from the lecture. I encourage you to work together with one or more friends on the homework assignments. It is more enjoyable that way, and you learn by explaining things to each other. Textbook: Young and Freedman, Sears and Zemansky's University Physics with Modern Physics, 14th Edition. Additional (optional) reading: R. P. Feynman, R. B. Leighton, & M. Sands, The Feynman Lectures on Physics. Howard Georgi, The Physics of Waves David Morin, (untitled) Waves, <http://www.people.fas.harvard.edu/~djmorin/book.html> Prerequisite: (MATH-SHU 121 or MATH-SHU 201) and PHYS-SHU 93. Fulfillment: Physics Foundational Courses.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Physics Foundational Course

**PHYS-SHU 96 Foundations of Physics IV Honors (3 Credits)***Typically offered occasionally*

Continuation of Foundation of Physics III. Topics include Relativity, Photon, Quantum Mechanics, Molecules and Condensed Matter, Nuclear Physics, Particle Physics and Cosmology. This is the fourth semester of a four-semester calculus-based introduction to Physics, and is intended for physics majors and other interested students. Textbook: Young and Freedman, Sears and Zemansky's University Physics with Modern Physics, 14th Edition. Prerequisite: PHYS-SHU 95 Found of Physics III Honors. Fulfillment: Physics Foundational Courses.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Physics Foundational Course

**PHYS-SHU 106 Mathematical Physics (4 Credits)***Typically offered Spring*

Mathematical preparation for the junior and senior courses in physics. Vector analysis, Fourier series and integrals, ordinary differential equations, matrices, partial differential equations, and boundary-value problems. Prerequisite: None. Fulfillment: Physics required course.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Physics Required

**PHYS-SHU 135 Solid-State Physics (4 Credits)***Typically offered every other year*

This course is designed as an introduction to condensed matter physics for students with knowledge of elementary quantum mechanics. Topics include crystal structure, lattice vibrations, and the energy band theory of metals and semiconductors. Covers the electronic, magnetic, and optical properties of solids. In addition, the course may include some modern research topics such as the physics of nanostructures, soft condensed matter physics, and superconductivity. Prerequisite# None. Fulfillment: Physics elective; Math Additional elective; Honors Math elective.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Honors Mathematics Math Elective
- SB Crse Attr. NYU Shanghai: Mathematics Additional Mathematics Elective
- SB Crse Attr. NYU Shanghai: Physics Elective

**PHYS-SHU 200 Optical Imaging: Applications in Biology and Engineering (2 Credits)***Typically offered occasionally*

Optics and imaging technology play very important roles in science and engineering. For example, the images collected by the Hubble Telescope, since year 1990, have revolutionized modern astronomy. In biology, the use of two-photon excitation microscopy has significantly advanced neuroscience, as we are now able to track the intracellular development at sub-micron resolutions. A typical course in optics offered at any university often focuses on the fundamental aspects of light but much less on its vast applications in the real world. This short course will exemplify the power and usefulness of optics in current sciences and technology, especially in biology and engineering. Prerequisite: None. Fulfillment: Physics elective.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Physics Elective

**PHYS-SHU 201 Introduction to Quantum Computing (4 Credits)***Typically offered Fall and Spring*

Quantum mechanics is the theory that tells us how everything we see around us - from atoms, light, electrons, to materials - behaves at the microscopic level. Starting from its abstract beginnings in the early 20th century, in the 21st century we are entering a new age where we can control individual atoms and create quantum systems for new technologies. This course gives a simplified introduction to quantum theory, for students who wish to understand quantum mechanics only to a basic level to see some of its applications. The first part of the course introduces the key aspects of quantum mechanics. In the second part we apply these ideas to technological applications such as quantum teleportation, quantum computing, and cryptography. Prerequisite: None. Fulfillment: Physics elective; Math Additional elective; Honors Math elective.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Honors Mathematics Math Elective
- SB Crse Attr: NYU Shanghai: Mathematics Additional Mathematics Elective
- SB Crse Attr: NYU Shanghai: Physics Elective

**PHYS-SHU 251 Electricity and Magnetism (4 Credits)***Typically offered occasionally*

Introduction to Maxwell's equations with applications to physical problems. Topics include electrostatics, magnetostatics, the solution of the Laplace and Poisson equations, dielectrics and magnetic materials, electromagnetic waves and radiation, Fresnel equations, transmission lines, and wave guides. Prerequisites: PHYS-SHU 95 Foundations of Physics III Honors and PHYS-SHU 106 Mathematical Physics. Fulfillment: Physics required.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Physics Required

**PHYS-SHU 301 Quantum Mechanics (4 Credits)***Typically offered occasionally*

Designed to provide a rigorous mathematical introduction to quantum mechanics, this course covers the Schrödinger and Heisenberg description of quantum systems, application to basic atomic structure and simple boundary condition problems, quantum statistics, and perturbation theory. PREREQ: Mathematical Physics (PHYS-SHU 106) AND Foundation of Physics III Fulfillment: Physics required.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Physics Required

**PHYS-SHU 302 Statistical Mechanics and Thermodynamics (4 Credits)***Typically offered occasionally*

Topics include relation of entropy to probability and energy to temperature, the laws of thermodynamics, Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics, equations of state for simple gases and chemical and magnetic systems, and elementary theory of phase transitions. Prerequisite: Foundation of Physics III Honors (PHYS-SHU 95) in SH or Physics III (PHYS-UA 95) in NY as the pre-req of PHYS-SHU 302 Statistical Mechanics Fulfillment: Physics required.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Physics Required

**PHYS-SHU 303 Advanced Physics Laboratory (4 Credits)***Typically offered occasionally*

A further development of the experimental techniques introduced in Foundations of Science as applied to modern physics. Following a number of introductory experiments, students have at their option a variety of open-ended experiments they can pursue, including the use of microcomputers for data analysis. Experimental areas include Mossbauer effect, cosmic rays, magnetic resonance, superfluidity and super-conductivity, and relativistic mass. Prerequisite: PHYS-SHU 95 Found of Physics III Honors. Fulfillment: Physics required.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Physics Required

**PHYS-SHU 315 Nuclear and Particle Physics (4 Credits)***Typically offered occasionally*

The phenomenology and experimental foundations of nuclear and particle physics are explored in this course, with emphasis on the fundamental forces underlying particle interactions. Prerequisite: Quantum Mechanics (PHYS-SHU 301) in SH or Quantum Mechanics I (PHYS-UA 123) in NY as the pre-req of PHYS-SHU 315 Nuclear and Particle Physics. Fulfillment: Physics elective.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Physics Elective

**PHYS-SHU 400 Physics Capstone Seminar (4 Credits)***Typically offered Spring*

Students design and conduct an independent research project in their area of focus using the theories, methods, and data with which they have become familiar over the course of completing the major. Open only to Physics majors in the senior year. Fulfillment: General Elective.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No**PHYS-SHU 997 Independent Study – Physics (2-4 Credits)***Typically offered Fall and Spring*

Prerequisite: Foundations of Science I-III (or Physics I&II, Foundations of Chemistry I&II, Foundations of Biology I&II), and a minimum GPA of 3.0 overall and in all science and mathematics courses required for the major, permission of a physics faculty member (at NYU-Shanghai, NYU-Abu Dhabi, or NYU-New York) who will act as a sponsor and mentor, and approval of the Director of Undergraduate Studies (DUS) in Physics. The faculty mentor must be selected in consultation with the DUS. Offered in the Fall, Spring or Summer. 2 to 4 points per term for a maximum of 4 points. This course aims at engaging students in research. It is designed to offer students an opportunity to observe physics research up close and gain hands-on research experience by working as a member in an active research team. Independent Study I and II can be done with the same supervisor or two different supervisors. No lectures will be given. Student researchers are expected to attend and actively participate in lab/supervision meetings. A Proposal for Independent Study form must be filled out, signed by the DUS, and submitted to the Registrar. Requires a written report on the research to be evaluated by the faculty sponsor, with a copy submitted to the DUS and a copy to the Dean of Arts & Sciences. Department consent is required. Fulfillment: Physics elective.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** Yes

- SB Crse Attr. NYU Shanghai: Physics Elective

**PHYS-SHU 998 Integrated Science Capstone (4 Credits)***Typically offered every year*

This course will provide students with a completion of their undergraduate science education by making use of the skills and knowledge they acquired over the course of completing their major to apply to scientific problems across disciplines. Students will be paired with a faculty mentor to engage either in Independent Research or Literature Review to address a scientific question of the student's design, culminating in a written report. Students are encouraged to work with faculty mentors outside of their own field. Open only to Biology, Chemistry, and Physics majors in the senior year. Prerequisite: senior students with physics major. Fulfillment: Physics required.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Physics Required

**PHYS-SHU 999 Physics Undergraduate Research Thesis (2 Credits)**

Prerequisites: Independent Study (PHYS-SHU 997 or 998), a minimum GPA of 3.65 overall, a minimum GPA of 3.65 in all science and mathematics courses required for the major, and permission of a faculty sponsor and the Dean of Arts & Sciences. Open to Physics majors only. The faculty mentor must be selected in consultation with the Dean of Arts & Sciences. May not be used for the major in physics. Offered in the fall, spring, and summer. 2 points. For physics majors who have completed at least one semester of laboratory research (PHYS-SHU 997 or 998) and are able to expand this work into a thesis. Requires writing a Thesis (i.e., a full literature search of the subject and a formal written report on the research in publication form), which is defended in front of a committee of three faculty (which includes the faculty sponsor), chosen by the student in consultation with the faculty mentor. (The defense may be a brief oral presentation followed by a question-and-answer session.) The Thesis and defense must be evaluated by the committee, with the cover page of the thesis signed by all committee members, with a copy of the Thesis submitted to the Dean of Arts & Sciences. (It is recommended that the student meet with the faculty committee at least once mid-semester to evaluate and guide the student's progress on the thesis work.) Prerequisite: none. Fulfillment: General Elective.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No**PHYS-SHU 1999 Physics Research in Shanghai (0 Credits)***Typically offered occasionally*

Prerequisite: None. Fulfillment: General Elective.

**Grading:** Class does not print on the transcript**Repeatable for additional credit:** No**PHYS-SHU 1999.1 Physics Research in Shanghai (1 Credit)**

Prerequisite: None. Fulfillment: General Elective.

**Grading:** Class does not print on the transcript**Repeatable for additional credit:** Yes