

PH-101 Principles of Physics

3 class hours 2 laboratory hours 4 credits
Presents a modern overview of the world around us, from the sub-miniature world inside an atomic nucleus to the vastness of outer space. Investigates selected subjects of interest to modern man in depth and detail. An understanding of physical principles is the major goal. Minimal use of mathematics. This course, or its equivalent, is required for elementary education majors at The City College.

PH-102 Physics from an Historical Viewpoint

3 class hours 2 laboratory hours 4 credits
Offered as needed. Satisfies the laboratory science requirement for a degree.
Traces the historical development of some key scientific ideas and the interaction of the individual scientist with his/her world. The relationship of science to major human events is considered. There is discussion of answers to such questions as: What is motion? What matters? What is life? What is man's relation to the rest of the universe? In the laboratory, experiments originally performed by famous scientists are recreated in an exact or simulated form.

PH-103 Frontiers of Physics

3 class hours 3 credits Offered as needed.
PH-103 and 104 together fulfill the laboratory science requirement for a degree.
An introduction to the ideas of research scientists of contemporary physics. Topics selected from such areas as astrophysics, atmospheric physics, atomic and nuclear physics, and medical applications. Lectures include multimedia illustrations of individual scientists in their actual working environment. Minimal use of mathematics.

PH-104 Frontiers of Physics

Laboratory
2 laboratory hours 1 credit Offered as needed.
Prerequisite or corequisite: PH-103. PH-103 and 104 together fulfill the laboratory science requirement for a degree.
Experiments arranged to illustrate the basic principles of physics on which contemporary research is based. Students become familiar with such equipment as the cloud chamber, Geiger counter, transistor, spectroscope, air pollution laboratory, and nuclear magnetic resonance apparatus.

PH-105 Introduction to Space Science I: Stars and Normal Galaxies

Offered as needed.

PH-106 Introduction to Space Science 2: The Universe Including Strange Galaxies

2 class hours and 2 credits for each course
Prerequisite for both courses: MA-010 or the equivalent
Offered as needed
An introduction to the Cosmos: stars, galaxies and the universe. Topics for 105 include gravitation, orbits, stellar lifecycles, the search for extra-solar planets and extraterrestrial life. Topics for 106 include galactic evolution (including quasars) and morphology, dark matter and large-scale structure, special and general relativity, black holes, and the Big Bang. Conceptual thinking and mathematical reasoning will be emphasized.
These courses will be taught at the American Museum of Natural History's Hayden Planetarium. They are designed as a two-semester sequence, but they may be taken separately and in either order. The two courses together would fulfill the non-laboratory science requirement. Individually, the courses will fulfill Liberal Arts and Sciences requirements.

PH-110 Principles of Astronomy and Space

3 class hours 2 laboratory hours 4 credits
Satisfies the laboratory science requirement for a degree.
Features and physical processes of sky objects studied, using minimal mathematics. Covers such topics as the earth, sun, moon, asteroids, comets, meteors, origin of the solar system, the evolution of stars, stellar clusters, the classification and evolution of galaxies, pulsars, quasars, and theories about the origin of the universe.

PH-120 Introduction to Meteorology

3 hours 3 credits
Introduces students to Meteorology and Atmospheric Sciences. The course presents basic scientific principles and how they apply to the atmosphere and oceans. Fulfills the science requirement without lab (or with lab if taken in conjunction with PH-121).

PH-121 Meteorology Laboratory

2 hours 1 credit
Introduces students to Meteorology and Atmospheric Sciences. The course presents basic scientific principles and how they apply to the atmosphere and oceans.

PH-140 Acoustics: The Physics of Sound

3 lecture hours 1 recitation hour 2 lab hours 4 credits
Corequisite: MA-321 or MA-120 or MA-114 or the equivalent.
Traveling waves and standing waves, energy, sound intensity, interaction of sound and materials, methods of sounds production by musical instruments, room acoustics, interference, human ear response to sound, magnetism and induction as they relate to audio equipment, microphones, speakers, pick-ups. This course is intended to satisfy the physics requirement for the Music Electronics Degree but is open to all majors.

PH-150 Introductory Laboratory in Fiber Optics

2 laboratory hours 1 credit Offered in Fall
Prerequisites: None
Introduces students to basic ideas and techniques related to fiber optics and its applications in telecommunications in a laboratory setting. Topics include preparation of fiber optic cables, the concept of attenuation, power ratios expressed in dB, use of fiber optic test sets, the idea of time domain reflectometry, how to use an optical time domain reflectometer and how to interpret its results, wave-division multiplexing.

PH-151 Introductory Laser Laboratory

2 laboratory hours 1 credit Offered in Spring
Prerequisites: None
Introduces students to lasers and some of the optical skills and concepts necessary for dealing with them. Students will get "hands-on" experience with several different types of lasers.

PH-201 General Physics I

3 class hours 2 laboratory hours 4 credits
Prerequisite: MA-114 or MA-120 or the equivalent, or satisfactory score on the Mathematics Placement Test (Level II, MA-120).
A beginning course for technology students. Topics include units, vectors, equilibrium, linear motion, Newton's laws, circular motion, angular motion, momentum, and fluid motion. Emphasis is on applications. A working knowledge of simple algebra is assumed.

PH-202 General Physics II

3 class hours 2 laboratory hours 4 credits
Prerequisite: PH-201 (with a grade of C or better)
Second semester of PH-201, 202 sequence. Topics include vibration and wave motion, electrostatics,

electric and magnetic fields, electromagnetic waves, optics and topics in modern physics.

PH-229 Introduction to Photonics

2 class hours 1 recitation hour 3 laboratory hours 4 credits
Corequisite: MA-114
Topics in optics related to lasers and optical fiber and devices for modulating and directing signals from such devices. Students will study geometrical optics with emphasis on ray tracing and the application to lenses (thick and thin), mirrors, prisms and other passive optical elements and systems. Students will study the propagation of light in materials and dispersion and its effects. Additional topics will include an introduction to lasers and fiber optics, including an introduction to the propagation of light through fibers. Laboratory exercises complement class work.

PH-230 Matrix Optics and Aberrations

1 lecture hour 1 recitation/lab hour 1 credit
Prerequisite: PH-229
Topics in matrix optics applied to geometric (ray) optics including beam propagation, thin and thick lenses and lens systems. Introduction to aberrations in optical systems, how they are formed and controlled.

PH-231 Fundamentals of Lasers and Fiber Optics

3 class hours 3 laboratory hours 4 credits
Corequisite: MA-114.
Topics in optics related to lasers and optical fiber and devices for modulating and directing signals from such devices. Geometrical optics with emphasis on ray tracing. Matrix methods in optics. Lenses thick and thin, mirrors, prisms and other passive optical elements and systems. Propagation of light in materials. Dispersion and its effects. Special topics in geometric and wave optics. Laboratory complements class work.

PH-232 Laser and Electro-Optics Technology**

3 class hours 2 recitation hours 3 laboratory hours 5 credits
Prerequisite: PH-231.
Wave optics, interference, coherence, polarization, birefringence, diffraction, gratings in two and three dimensions, power and energy measurements, basics of laser safety, ultra-fast pulse techniques, electro-optic and acousto-optic switches, optical materials, non-linear optics. Laboratory complements class work.

**Students registering in PH-232 are required to pay a special services charge of \$10.00.

PH-233 Laser Electro-Optics Devices, Measurements and Applications

3 class hours 3 laboratory hours 4 credits
Prerequisite: PH-231.
Laser as a device, principle of operation, cavity modes and their control (tuning elements, Q switching, mode-locking) and detection, laser design, types of lasers, includes discussion of laser types for medical, ranging and tracking, material processing, pollution monitoring, and optical memory applications, semiconductor laser. Laboratory complements class work.

PH-234 Fiber Optics Devices, Measurements and Applications ✦

3 class hours 3 laboratory hours 4 credits
Prerequisites: PH-231, or ET-220 and PH-202.
Propagation of light in optical fiber, including analysis of the behavior of different modes. Dispersion and distortion. Specialized light sources and their characterization. Fiber optic sensors. All-optical fiber amplifiers. Optical switches and logic gates. Optical isolators. Techniques for joining fibers. Instruments for characterizing fiber and fiber links. Optical communications systems and protocols. Wavelength division multiplexing. Medical applications including fiber optics-diagnostic and surgical. Optical data processing and optical memories. Laboratory complements class work.

PH-235 Laser/Electro-Optics Projects

2 class hours 3 laboratory hours 3 credits
Prerequisite: PH-231
Corequisite: ET-910 or permission of the Dept.
Construction and testing of a laser, optical or electro-optic device such as a helium-neon laser, optical power meter, or fiber optics communication link; oral presentations and computerized literature searches.

PH-236 Introduction to Computers in Electro-Optics

1 class hour 3 laboratory hours 2 credits
Prerequisite: PH-231
Corequisite: MA-128 or the equivalent.
Elements of a computer system and an introduction to computer languages. Scientific programming using BASIC/FORTRAN with applications in optics. Use of commercial optics programs. Digital techniques including number systems, logic gates, Karnaugh mapping, Boolean algebra, combinational logic design, sequential logic design.

PH-240 Computerized Physical Measurement Using Graphical Programming

2 lecture hours 3 laboratory hours 3 credits
Prerequisites: Permission of the department based on one laboratory course in science or technology; MA-114, MA-120 or the equivalent; and ET-501, PH-303, BU-500 or the equivalent
Students will design applications with a graphical programming language such as LabVIEWTM and use the computer for measurement and automation. Topics include: theory of measurement, physical principles of transducers and their use in measurement, instrument control, data acquisition, virtual instrumentation, signal/data conditioning and analysis.

PH-301 College Physics I

3 class hours 1 recitation hour 2 laboratory hours 4 credits
Prerequisite: MA-120 or MA-114 or equivalent or permission of the department
PH-301 and 302 are designed for students who need or want two semesters of noncalculus physics, such as those planning careers in optometry, dentistry, and other medically-related fields. Topics include conservation laws, vectors, laws of motion, linear and angular momentum, energy, gravitation, and thermodynamics.

PH-302 College Physics II

3 class hours 1 recitation hour 2 laboratory hours 4 credits
Prerequisite: PH-301 (with a grade of C or better)
Second-semester course following PH-301. Topics include electro-magnetism, vibrations wave phenomena and radiation, and modern physics.

PH-303 Scientific Use of Computers

1 lecture hour, 2 laboratory hours, 2 credits
Offered as needed Prerequisite: MA-010
PH-303 fulfills the computer applications requirement for the A.S. in Health Sciences, and can be used as a concentration elective in the A.S. in Liberal Arts and

Sciences (Mathematics and Science).

Introduces students to computers and the ways they are used in scientific work. This course includes elements of scientific programming and scientific data collection and analysis. Presentation and dissemination are also included. Automated data acquisition from a variety of sensors. Databases and spreadsheets. Presentations with graphs and text as well as dissemination via the Internet/E-mail are covered.

PH-411 Calculus Physics I

2 class hours 2 recitation hours 2 laboratory hours 3.5 credits
Prerequisite: MA-440, or the equivalent. Corequisite: MA-441.
Fundamental principles of mechanics; includes kinematics, classical laws of motion, statics, conservation laws, work, mechanical energy, and simple harmonic motion.

PH-412 Calculus Physics II

2 class hours 2 recitation hours 2 laboratory hours 3 credits
Prerequisite: PH-411 (with a grade of C or better)
Corequisite: MA-442.
Fundamentals of heat, waves, and optics; includes heat transfer, first and second laws of thermodynamics, kinetic theory of gases; nature of light, geometrical and physical optics; optical instruments; sound.

PH-413 Calculus Physics III

2 class hours 2 recitation hours 2 laboratory hours 3.5 credits
Prerequisite: PH-411 (with a grade of C or better)
Corequisite: MA-443.
Electricity and magnetism. Includes Coulomb's law, electric field and potential, elementary DC and AC circuits; magnetic fields, induction, Maxwell's equations.

PH-414 Analytical Mechanics

4 class hours 4 credits Offered as needed.
Prerequisite: PH-411. Corequisite: MA-443.
Engineering mechanics including statics and dynamics in three dimensions. Additional topics of theoretical or mathematical mechanics considered to extent of available time.

PH-415 Electricity and Magnetism

4 class hours 4 credits Offered as needed.
Prerequisite: PH-413. Corequisite: MA-443.
Basic concepts of electrostatics, electrostatics, circuits, network theory, transients, vector treatment of AC circuits, and magnetically-coupled circuits.

PH-416 Thermodynamics

4 class hours 4 credits
Prerequisite: PH-412 and MA-443.
Introduction to concepts and definitions of thermodynamics. Temperature and Zeroth Law. Work, internal energy, heat, the First Law and applications. Second Law, reversibility and irreversibility, Carnot cycles, entropy, thermodynamic state variables. Power and refrigeration cycles. Chemical equilibrium, chemical potentials, phase rules.

PH-431 Calculus Optics

1 class hour 2 recitation hours 2 credits
Offered as needed
Prerequisite: PH-201 or PH-411, MA-441.
corequisite: PH-231 and MA-442
The theory of diffraction and its applications to modern optics. Maxwell's equations in differential form with solutions for plane refraction. Propagation of electromagnetic radiation and Poynting's vector. Gain in laser mediums. Modulation of lasers. Calculus used throughout. The department advises students who anticipate transferring into a Bachelor's degree program in Photonics or Engineering to take PH-413 and MA-443 with or before this course.

PH-440 Modern Physics

4 class hours 4 credits
Prerequisites: PH-412 and PH-413.
Introduction to atomic and nuclear physics, relativity, space physics, and elementary particle physics. Considerable mathematics used.
PH-931 Cooperative Education in Laser and Fiber-Optics Technology
1 class hour plus a minimum of 135 hours of appropriate work experience 3 credits
Prerequisite: a minimum of 12 credits in laser and fiber-optics technology courses
Cooperative education involves employment with a company in the laser, optics, fiber-optics or related fields. The experience supplements classroom theory and instruction with on-the-job professional training. The experience includes training in skills and/or with equipment beyond the ordinary classroom in a real job atmosphere. Students are placed in a work situation for a minimum of 135 hours, meet with the course coordinator twice a month and present orally and submit in writing a term project report related to the work experience. In addition, a written evaluation is provided by the employer. Students receive a pass/fail grade.

✦ Students registering in PH-234 are required to pay a special services charge of \$40.00.