Physics (PHYS)

Physics (PHYS) Courses

Physics

Faculty of Science

PHYS 1001 [0.5 credit]
Foundations of Physics I
This calculus-based course covers mechanics, gravitation, oscillations, and thermodynamics. The laboratory is an essential and autonomous part of the course. This is a specialist course for students intending to take further courses in Physics.
Precludes additional credit for PHYS 1003 and PHYS 1007.
Prerequisite(s): Grade 12 Mathematics: Advanced Functions and Grade 12 Mathematics: Calculus and Vectors or equivalent, plus one of MATH 1004 or MATH 1002 (the MATH course may be taken concurrently); or permission of the Physics Department. Grade 12 Physics is strongly recommended. .
Lectures three hours a week, laboratory or tutorial three hours a week.

PHYS 1002 [0.5 credit]
Foundations of Physics II
An introduction to relativity, electricity, magnetism, wave motion and quantum mechanics. The laboratory is an essential and autonomous part of the course. This is a specialist course for students intending to take further courses in physics.
Precludes additional credit for PHYS 1004 and PHYS 1008.
Prerequisite(s): PHYS 1001, or PHYS 1003, or PHYS 1007 with a grade of B-; MATH 1004 or MATH 1002 (may be taken concurrently); or permission of the Department.
Lectures three hours a week, laboratory or tutorial three hours a week.

PHYS 1003 [0.5 credit]
Introductory Mechanics and Thermodynamics
Mechanics, gravitation, oscillations, and thermodynamics. The application of calculus to solve problems in these areas of physics is introduced. This course is intended for students in the physical sciences and engineering. The laboratory is an essential and autonomous part of the course.
Precludes additional credit for PHYS 1001 and PHYS 1007.
Prerequisite(s): Grade 12 Physics or equivalent, plus Grade 12 Mathematics: Advanced Functions or equivalent, plus one of MATH 1004 or MATH 1002 (the MATH course may be taken concurrently). Note that Grade 12 Mathematics: Calculus and Vectors is strongly recommended. .
Lectures three hours a week, laboratory or tutorial three hours a week.

PHYS 1004 [0.5 credit]
Introductory Electromagnetism and Wave Motion
This calculus-based course introduces electricity, magnetism, oscillations, waves and optics. The laboratory is an essential and autonomous part of the course.
Precludes additional credit for PHYS 1002 and PHYS 1008.
Prerequisite(s): MATH 1004, ECOR 1101 (may be taken concurrently) or PHYS 1001 or PHYS 1003 or PHYS 1007 (a grade of at least B- is required for PHYS 1007), or permission of the Department.
Lectures three hours a week, laboratory or tutorial three hours a week.

PHYS 1007 [0.5 credit]
Elementary University Physics I
Mechanics, properties of matter, thermodynamics. Applications chosen in part from the life sciences. For students who lack the prerequisites for PHYS 1001 or PHYS 1003, or who do not intend to take upper-year courses in Physics.
Precludes additional credit for PHYS 1001 and PHYS 1003 and BIT 1002.
Prerequisite(s): (i) Grade 12 Mathematics: Advanced Functions or equivalent, or MATH 0107 (may be taken concurrently); or (ii) Grade 12 Mathematics: Calculus and Vectors or equivalent, or MATH 1007 (may be taken concurrently; or (iii) permission of the Physics Department.
Lectures three hours a week, laboratory or tutorial three hours per week.

PHYS 1008 [0.5 credit]
Elementary University Physics II
Electricity and magnetism, DC and AC circuits, wave motion and light. Elements of modern physics. Applications chosen in part from the life sciences.
Precludes additional credit for PHYS 1002 and PHYS 1004 and BIT 1003.
Prerequisite(s): PHYS 1001 or PHYS 1003 or PHYS 1007.
Lectures three hours a week, laboratory or tutorial three hours per week.

PHYS 1901 [0.5 credit]
Planetary Astronomy
Description of the known stellar, galactic and extra-galactic systems together with the instruments used to study them. Modern ideas concerning the structure, origin and evolution of our own planet. Formation of the Moon - Earth system. Study of the planets in our solar system. A 14" telescope is available for student use.
Note: Science students may only take this course as a free elective.
Precludes additional credit for PHYS 2203.
Lectures two and one-half hours a week.

PHYS 1902 [0.5 credit]
From our Star to the Cosmos
Starting with the Sun, the course studies its composition and source of power, then compares our Sun with the other stars in the galaxy and beyond. Modern ideas concerning the structure, origin and evolution of the universe, pulsars and supernovae are examined. A 14-inch telescope is available for student use.
Note: Science students may only take this course as a free elective.
Precludes additional credit for PHYS 2203.
Lectures two and one-half hours a week.

PHYS 1905 [0.5 credit]
How Things Work: Physics in Everyday Life
Intended for students with little or no background in Science. Examination of the physics behind everyday objects to learn about the basis for our modern technological world. Topics may include cell phones, microwave ovens, sustainable energy, weather, dance, music, hockey, and skiing.
Faculty of Science students may only take this course as a free elective.
Lectures three hours a week.

PHYS 2004 [0.5 credit]
Modern Physics for Engineers
Introduction to aspects of modern physics relevant to engineering. Thermal radiation. Concepts of relativistic kinematics. Wave-particle duality. Elements of quantum mechanics. Optical and x-ray spectra, lasers. Nuclear physics and applications. Condensed matter physics.
Precludes additional credit for PHYS 2604.
Prerequisite(s): PHYS 1002 or PHYS 1004 or PHYS 1008 with a grade of B- or better, plus MATH 1004 and MATH 1104 or equivalent. Restricted to B.Eng. students not in the Engineering Physics program. Students in programs other than B.Eng. must obtain permission of the Department.
Lectures three hours a week.

PHYS 2101 [0.5 credit]
Mechanics and Properties of Matter
Equations of motion for a single particle. Harmonic oscillation. Noninertial reference frames. Orbits in a central force field. Motion of systems of particles and of rigid bodies. Introduction to special relativity. Laboratory experiments in classical mechanics and properties of matter.
Prerequisite(s): PHYS 1001 and PHYS 1002, or PHYS 1003 and PHYS 1004, alternatively PHYS 1007 and PHYS 1008 with an overall average of B- or better; MATH 1004 and MATH 1104, or MATH 1002 and MATH 1102.
Lectures three hours a week, laboratory three hours a week, tutorials (optional) once a week.

PHYS 2202 [0.5 credit]
Wave Motion and Optics
Physical optics based on electromagnetic theory, oscillator model for dispersion, absorption, scattering, Huygen's principle, reflection and transmission as coherent scattering. Interference, coherence length, diffraction, polarization, double refraction. Geometrical optics.
Prerequisite(s): PHYS 1001 and PHYS 1002, or PHYS 1003 and PHYS 1004 (PHYS 1007 and PHYS 1008 are also acceptable provided a minimum average grade of B- is presented); plus MATH 1004 and MATH 1104, or MATH 1002 and MATH 1102.
Lectures three hours a week, laboratory three hours a week.

PHYS 2203 [0.5 credit]
Astronomy
The observational basis of astronomy. The history of astronomy, properties of light, solar system observations and stellar astronomy.
Precludes additional credit for PHYS 1901 and PHYS 1902.
Prerequisite(s): PHYS 1002 or PHYS 1004 or permission of the department. PHYS 1008 with a grade of B- or better may also be used if MATH 1004 or MATH 1007 or MATH 1002 have been successfully completed.
Lectures three hours a week.

PHYS 2305 [0.5 credit]
Electricity and Magnetism
Electrostatics, field intensities in various charge configurations, Gauss' law, electrostatic energy. Dielectric materials, dipoles, molecular polarizability. Steady currents, properties of electrical conductors. Magnetic effects of currents and motion of charges in electric and magnetic fields. Time varying currents, electromagnetic induction. Magnetic materials and magnetic measurements.
Prerequisite(s): PHYS 1001, PHYS 1002, or PHYS 1003 and PHYS 1004, alternatively PHYS 1007 and PHYS 1008 with an overall grade of B- or better.
Lectures three hours a week, laboratory three hours a week.

PHYS 2306 [0.5 credit]
Physics of Electrical and Electronic Measurements I
D.C. and A.C. circuit theory. Resonant circuits. Basic measuring devices, the oscilloscope; impedances, bandwidth, noise; vacuum tubes, transistors, useful approximations for circuit design; feedback, amplifiers, oscillators; operational circuits; digital circuits. Lectures emphasize the physical basis of instrument design. Laboratory emphasizes modern digital instrumentation.
Prerequisite(s): PHYS 1001, PHYS 1002 or PHYS 1003 and PHYS 1004, alternatively PHYS 1007 and PHYS 1008 with an overall grade of B- or better.
Lectures three hours a week, laboratory three hours a week.

PHYS 2604 [0.5 credit]
Modern Physics I
The course is designed to provide a logical transition from classical to modern physics. Special relativity. Kinetic theory. Thermal radiation. Rutherford scattering, atomic models. Photoelectric effect, Compton scattering. Bohr theory of the hydrogen atom. Atomic energy states, optical spectra, lasers. X-rays. Radioactivity. Quantum Mechanics.
Precludes additional credit for PHYS 2004.
Prerequisite(s): PHYS 1001 and PHYS 1002, or PHYS 1003 and PHYS 1004 (PHYS 1007 and PHYS 1008 are also acceptable provided a minimum average grade of B- is presented); plus MATH 1004 and MATH 1104, or MATH 1002 and MATH 1102.
Lectures three hours a week, laboratory three hours a week.

PHYS 2903 [0.5 credit]
Physics and the Imagination
Physics has had a profound influence on music, philosophy, literature, film, and art. This is examined in a conceptual, non-technical, manner. A selection of topics will be studied.
Note: Faculty of Science students may only take this course as a free elective.
Prerequisite(s): second-year standing.
Lectures and discussion groups three hours a week.

PHYS 3007 [0.5 credit]
Third Year Physics Laboratory: Selected Experiments and Seminars
Students complete a small number of experiments selected from modern optics, holography, atomic physics, nuclear spectroscopy, radiation, etc. An exercise on literature searches and student seminars on experimental and numerical methods are included.
Prerequisite(s): PHYS 2202 and PHYS 2604, or permission of the Department.
Six hours a week.

PHYS 3008 [0.5 credit]
Third Year Physics Laboratory: Selected Experiments and Workshop
Students complete a small number of experiments selected from modern optics, holography, atomic physics, nuclear spectroscopy, radiation, etc. Instruction on instrumentation building techniques will be given.
Prerequisite(s): PHYS 2202 and PHYS 2604, or permission of the department.
Six hours a week.

PHYS 3207 [0.5 credit]
Topics in Biophysics
An introduction is made to biophysics. Topics in biology: animal movement, food irradiation, DNA damage and repair following irradiation, quantum tunneling in enzyme kinetics. Applications of physics in medicine: radiobiology, cancer treatment, and medical imaging.
Prerequisite(s): PHYS 2604 or permission of the Department.
Lectures three hours a week, tutorial or seminar one hour a week.

PHYS 3308 [0.5 credit]
Electromagnetism
Electrostatic field and magnetostatics. Examples involving Laplace's and Poisson's equations; vector potential; Faraday's laws of induction; Maxwell's equations, waves in vacuum and dielectric media, guided waves.
Precludes additional credit for ELEC 3909.
Prerequisite(s): PHYS 2202, PHYS 2604, MATH 2004 or MATH 2008, and MATH 3705, or permission of the Department.
Lectures three hours a week.

PHYS 3402 [0.5 credit]
Heat and Thermodynamics
Zeroth, First, Second and Third Laws of Thermodynamics; enthalpy, Helmholtz and Gibbs functions and the Maxwell relations; phase transitions; thermodynamics of magnetism; cryogenics cooling by Joule-Thompson effect, adiabatic expansion of a gas, adiabatic demagnetization, helium dilution refrigeration; black body radiation; negative temperatures.
Prerequisite(s): PHYS 2101 and PHYS 2305, MATH 2007, MATH 2008, MATH 2107 and MATH 2401 or permission of the Department.
Lectures three hours a week.

PHYS 3606 [0.5 credit]
Modern Physics II
Elements of condensed matter physics, semiconductors, superconductivity. Elements of nuclear physics, fission, fusion, power generation. Introduction to particle physics. Ionizing radiation: production, interactions, detection. Medical physics: radiation biophysics, cancer therapy, imaging.
Also offered, with different requirements, as PHYS 3608 for which additional credit is precluded.
Prerequisite(s): PHYS 2604 and PHYS 3701, or permission of the Department.
Lectures three hours a week, laboratory two hours a week.

PHYS 3608 [0.5 credit]
Modern Applied Physics
Elements of condensed matter physics, semiconductors, superconductivity. Modern optics. Elements of nuclear physics, fission, fusion, power generation. Ionizing radiation: production, interactions, detection. Medical physics: radiation biophysics, cancer therapy, imaging. Also offered, with different requirements, as PHYS 3606 for which additional credit is precluded.
Prerequisite(s): PHYS 2604 and PHYS 3701, or permission of the Department.
Lectures three hours a week, laboratory three hours a week.

PHYS 3701 [0.5 credit]
Elements of Quantum Mechanics
Analysis of interference experiments with waves and particles; fundamental concepts of quantum mechanics, Schrödinger equation; angular momentum, atomic beams; hydrogen atom; atomic and molecular spectroscopy; Pauli principle; simple applications in the physics of elementary particles.
Prerequisite(s): PHYS 2604, MATH 2000 [1.0] (may be taken concurrently), or MATH 2004 or MATH 2008, and MATH 3705 (may be taken concurrently), or permission of the Department.
Lectures three hours a week.

PHYS 3801 [0.5 credit]
Classical Mechanics
Introduction to Lagrangian and Hamiltonian mechanics: Poisson brackets, tensors and dyadics; rigid body rotations: introductory fluid mechanics coupled systems and normal coordinates; relativistic dynamics.
Prerequisite(s): PHYS 2101, PHYS 2202, PHYS 2305, MATH 2007, MATH 2008, MATH 2107, MATH 2401 or permission of the Department.
Lectures three hours a week.

PHYS 3802 [0.5 credit]
Advanced Dynamics
Equations of motion for a single particle. Oscillatory Motion. Lagrangian and Hamiltonian formulations of mechanics. Central force motion. Motion of systems of particles and of rigid bodies.
Prerequisite(s): PHYS 2202, PHYS 2604, and MATH 2004, or permission of the Department.
Lectures three hours a week.

PHYS 3807 [0.5 credit]
Mathematical Physics I
Boundary Value problems involving curvilinear coordinates; spherical harmonics, Bessel functions, Green's functions. Functions of a complex variable: analytic functions, contour integration, residue calculus.
Precludes additional credit for MATH 3007 or MATH 3057.
Prerequisite(s): PHYS 2202, MATH 2004, MATH 3705 or permission of the Department.
Lectures three hours a week, tutorial one hour a week.

PHYS 3808 [0.5 credit]
Mathematical Physics II
Solution of second-order total differential equations by Frobenius' method. Sturm-Liouville theory. Special functions: Legendre, Bessel. Hermite, Laguerre and associated functions. Partial differential equations: method of separation of variables, eigenfunctions and eigenvalues and eigenfunction expansions. Green's function techniques for solving inhomogeneous partial differential equations.
Precludes additional credit for MATH 3004, MATH 3008, MATH 3705, and PHYS 3806.
Prerequisite(s): PHYS 3807 or MATH 3007 or permission of the Department.
Lectures three hours a week.

PHYS 3999 [0.0 credit]
Co-operative Work Term Report
Provides practical experience for students enrolled in the Co-operative option. Students must receive satisfactory evaluations from their work term employer. Written and oral reports will be required. Graded as Sat or Uns.
Prerequisite(s): registration in the Physics Co-operative education option and permission of the Department. .
Four-month work term.

PHYS 4007 [0.5 credit]
Fourth-Year Physics Laboratory: Selected Experiments and Seminars
Students complete a small number of experiments selected from modern optics, holography, atomic physics, nuclear spectroscopy, radiation, etc. An exercise on literature searches and student seminars on experimental and numerical methods are included.
Prerequisite(s): PHYS 3606 (or PHYS 3608) and registration in the Engineering Physics program.
Laboratory, six hours a week.

PHYS 4008 [0.5 credit]
Fourth-Year Physics Laboratory: Selected Experiments and Workshop
Students complete a small number of experiments selected from modern optics, holography, atomic physics, nuclear spectroscopy, radiation, etc. Instruction on instrumentation building techniques will be given.
Prerequisite(s): PHYS 3007.
Six hours a week.

PHYS 4201 [0.5 credit]
Astrophysics
Stellar evolution, including stellar modeling, main sequence stars, red giants and the end states of stars such as neutron stars and black holes. Neutrino astrophysics.
Prerequisite(s): PHYS 3701, PHYS 3606 or PHYS 3608 and PHYS 4409, or permission of the Department. (PHYS 3606 or PHYS 3608 and PHYS 4409 may be taken concurrently).
Lectures three hours a week.

PHYS 4202 [0.5 credit]
Cosmology
Observational evidence for the Big Bang. Introduction to general relativity, expansion dynamics and contents of the universe. Physical processes in the expanding universe, inflation, nucleosynthesis, the cosmic microwave background, dark matter, and dark energy.
Prerequisite(s): PHYS 3701, PHYS 3606 or 3608 and PHYS 4409, or permission of the Department. (PHYS 3606 or PHYS 3608 and PHYS 4409 may be taken concurrently.).
Lectures three hours per week.

PHYS 4203 [0.5 credit]
Physical Applications of Fourier Analysis
Fourier transform, convolution. Sampling theorem. Applications to imaging: descriptors of spatial resolution, filtering. Correlation, noise power. Discrete Fourier transform, FFT. Filtering of noisy signals. Image reconstruction in computed tomography and magnetic resonance. Laplace transform. Integral transforms, application to boundary value problems.
Prerequisite(s): MATH 3705, or permission of the Department.
Lectures three hours a week.

PHYS 4208 [0.5 credit]
Modern Optics
Electromagnetic wave propagation; reflection, refraction; Gaussian beams and guided waves. Laser theory: stimulated emission, cavity optics, modes, gain and bandwidth; atomic and molecular lasers. Mode locking, Q switching. Diffraction theory, coherence, Fourier optics, holography, laser applications. Optical communication systems, nonlinear effects: devices, fibre sensors, integrated optics.
Prerequisite(s): PHYS 2202, PHYS 3606 (or PHYS 3608), and PHYS 3308 or permission of the Department.
Also offered at the graduate level, with different requirements, as PHYS 5318, for which additional credit is precluded.
Lectures three hours a week.

PHYS 4307 [0.5 credit]
Electromagnetic Radiation
Electromagnetic wave propagation in a vacuum, dielectrics, conductors, and ionized gases, reflection, refraction, polarization at the plane boundary between two media; waveguide and transmission line propagation; dipole and quadrupole radiation fields; antenna systems. Electromagnetic mass, radiation pressure. Tensor notation, transformation of the electromagnetic fields.
Prerequisite(s): PHYS 3308, PHYS 3801, PHYS 3807 and PHYS 3808 (except for Mathematics and Physics Double Honours students), or permission of the Department.
Lectures three hours a week.

PHYS 4407 [0.5 credit]
Statistical Physics
Equilibrium statistical mechanics and its relation to thermodynamics. Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics are derived, and applied in appropriate physical situations. Fluctuations. Kinetics and transport processes, including the Boltzmann transport equation and some of its applications.
Prerequisite(s): PHYS 3402, PHYS 2602 or PHYS 3601, PHYS 3701 or PHYS 3602, PHYS 4707 (may be taken concurrently); or permission of the Department.
Lectures three hours a week.

PHYS 4409 [0.5 credit]
Thermodynamics and Statistical Physics
The three Laws of Thermodynamics, enthalpy, Helmholtz and Gibbs functions. Equilibrium statistical mechanics and its relation to thermodynamics. Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics.
Precludes additional credit for PHYS 3402 and PHYS 4407.
Prerequisite(s): PHYS 3701 (may be taken concurrently), MATH 2004 and MATH 3705, or permission of the Department.

PHYS 4508 [0.5 credit]
Solid State Physics
An introduction to solid state physics. Topics include crystal structure, phonons and lattice vibrations, conductors, semiconductors, insulators and superconductivity.
Prerequisite(s): PHYS 3606 or PHYS 3608, and PHYS 3701, or permission of the Department.
Lectures three hours a week.

PHYS 4602 [0.5 credit]
Particle Physics
Properties of leptons, quarks and hadrons. The fundamental interactions, conservation laws, invariance principles and quantum numbers. Resonances in hadron-hadron interactions. Three body phase space. Dalitz plots. Quark model of hadrons, mass formulae. Weak interactions, parity violation, decay of neutral kaons, CP violation, Cabibbo theory.
Prerequisite(s): PHYS 4707 or permission of the Department.
Also offered at the graduate level, with different requirements, as PHYS 5602, for which additional credit is precluded.
Lectures three hours a week.

PHYS 4608 [0.5 credit]
Nuclear Physics
Ground state properties of nuclei. Nuclear models, binding energy, properties of excited nuclei. Alpha, beta and gamma decay. Passage of radiation through matter, detectors. Nuclear reactions, cross sections, fission, fusion. Elements of neutron physics.
Prerequisite(s): PHYS 3606 or PHYS 3608 or permission of the Department.
Lectures three hours a week.

PHYS 4707 [0.5 credit]
Introduction to Quantum Mechanics I
The basic interpretative postulates of quantum mechanics are applied to simple one-dimensional problems, and angular momentum theory.
Prerequisite(s): PHYS 3701 and PHYS 3807 or equivalent, or permission of the Department.
Lectures three hours a week.

PHYS 4708 [0.5 credit]
Introduction to Quantum Mechanics II
Scattering theory and application; bound state problems; approximation methods.
Prerequisite(s): PHYS 4707 or permission of the Department.
Lectures three hours a week.

PHYS 4807 [0.5 credit]
Computational Physics
Computational methods used in analysis of experimental data. Introduction to probability and random variables. Monte Carlo methods for simulation of random processes. Statistical methods for parameter estimation and hypothesis tests. Confidence intervals. Multivariate data classification. Unfolding methods. Examples primarily from particle and medical physics.
Prerequisite(s): third year standing in a physics program and an ability to program in FORTRAN, Java, C or C++, and permission of the Department.
Also offered at the graduate level, with different requirements, as PHYS 5002, for which additional credit is precluded.
Lectures three hours a week.

PHYS 4901 [0.5 credit]
Special Topics in Physics
Each year, at the direction of the Department, a course on a special topic may be offered.
Prerequisite(s): permission of the Department.

PHYS 4907 [0.5 credit]
Fourth-Year Project
Same as PHYS 4909 except that it extends over the fall term only. (See PHYS 4909 for details.).
Prerequisite(s): permission of the Department.
A minimum of six hours laboratory or private study a week.

PHYS 4908 [0.5 credit]
Fourth-Year Project
Same as PHYS 4909 except that it extends over the winter term only. (See PHYS 4909 for details.).
Prerequisite(s): permission of the Department.
A minimum of six hours laboratory or private study a week.

PHYS 4909 [1.0 credit]
Fourth-Year Project
These are advanced projects of an experimental or theoretical nature with an orientation towards research. A written progress report, by mid-term for PHYS 4907, PHYS 4908, and by mid-year for PHYS 4909, must be submitted to the student's supervisor prior to the last day for withdrawal from the course. A written and an oral report are required at the conclusion of the project.
Prerequisite(s): permission of the Department.
A minimum of six hours laboratory or private study a week.

Summer session: some of the courses listed in this Calendar are offered during the summer. Hours and scheduling for summer session courses will differ significantly from those reported in the fall/winter Calendar. To determine the scheduling and hours for summer session classes, consult the class schedule at central.carleton.ca

Not all courses listed are offered in a given year. For an up-to-date statement of course offerings for the current session and to determine the term of offering, consult the class schedule at central.carleton.ca