

# PHYSICS (PHYS)

## PHYS 1018 The Mechanics of Nature 3 cr

This course provides an overview of how aspects of the natural world can be modeled using the laws of mechanics within the contexts of everyday life, including astronomy and biology. Students will learn conceptual and calculational tools used to discover the essential physics observed in everyday experiences. Suitable for students seeking an introductory-level general-interest science course, and students seeking to prepare for taking other first year Physics and Astronomy courses. May not be used for credit in a Physics and Astronomy Honours, Joint Honours, or Major program. Not available to students who have previously obtained credit (grade of C or better) in PHYS 1020, PHYS 1021, PHYS 1050, or PHYS 1051.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Pre- or corequisite: one of MATH 0401, MATH 1018, Applied Mathematics 40S, Pre-calculus Mathematics 40S, MSKL 0100, or equivalent.

**Mutually Exclusive:** PHYS 1020, PHYS 1021, PHYS 1050, PHYS 1051

**Attributes:** Science, Recommended Intro Courses

## PHYS 1020 General Physics 1 3 cr

(Lab Required) It's a crazy world; come and find out why objects fall, slide, bounce, stick, go in circles or stay straight, float or sink, glide or crash. Why don't satellites fall to the ground? What exactly does weightlessness mean anyway? Find answers to these and other questions as you get to know Newton's and other basic laws of nature and see what makes the world go round. This course, together with the sequel PHYS 1030, is recommended for students seeking either a single, comprehensive course in Physics or entry into health science programs. It may also be used for entry into the Honours Physics program ("B+" or better) or the Major Physics program ("B" or better). May not be held with PHYS 1021, PHYS 1050, PHYS 1051, the former PHYS 1410, or the former PHYS 1420.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: (one of Physics 40S, PHYS 0900 (P), PSKL 0100 (P) offered by Extended Education, or equivalent) and (one of Pre-calculus Mathematics 40S, Applied Mathematics 40S (with 70% or better), MSKL 0100 offered by Extended Education, or equivalent). It is strongly recommended that students attain a minimum of 70% as the average of their marks in Physics 40S and Pre-calculus Mathematics 40S.

**Equiv To:** PHYS 1021

**Mutually Exclusive:** PHYS 1018, PHYS 1050, PHYS 1051, PHYS 1410, PHYS 1420

**Attributes:** Mathematics Requirement, Science, Recommended Intro Courses

## PHYS 1030 General Physics 2 3 cr

(Lab Required) Discover how physics is the basis of the hi-tech world we live in and how we live in it. Learn how to use simple, intuitive physics concepts that are described using little math and no calculus to understand a diversity of topics including how electricity is made, what drives the greenhouse effect, what makes a diamond sparkle, lasers, LASIC eye surgery and the workings of the human eye. This course, together with its prerequisite PHYS 1020, is recommended for students seeking either a single comprehensive course in Physics, or entry into health science programs. This course may not be held with PHYS 1031, the former PHYS 1410 the former PHYS 1420.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: one of PHYS 1020, PHYS 1021, PHYS 1050, or PHYS 1051.

**Equiv To:** PHYS 1031

**Mutually Exclusive:** PHYS 1410, PHYS 1420

**Attributes:** Mathematics Requirement, Science, Recommended Intro Courses

## PHYS 1050 Physics 1: Mechanics 3 cr

(Lab required) It's rocket science! Mechanics is the science of describing (Kinematics) and explaining (Dynamics) motion. The basic concepts of calculus together with laws of conservation of momentum and energy are used to develop the tools required to describe, analyze and predict the outcomes of linear and rotational motion in simple mechanical systems. A brief introduction to the Einstein theory of special relativity provides a taste of modern approaches to this subject. This course develops a strong scientific foundation for students considering a program of study in engineering or the physical sciences. May not be held with PHYS 1020, PHYS 1021, PHYS 1051, the former PHYS 1410, or the former PHYS 1420.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: one of Physics 40S (60% or better), PHYS 0900 (P) or PSKL 0100 (P) offered by Extended Education, or equivalent. Pre- or corequisite: one of MATH 1230, MATH 1500, MATH 1501, MATH 1510, MATH 1520, the former MATH 1530, or MATH 1690.

**Equiv To:** PHYS 1051

**Mutually Exclusive:** PHYS 1018, PHYS 1020, PHYS 1021, PHYS 1410, PHYS 1420

**Attributes:** Science, Recommended Intro Courses

## PHYS 1070 Physics 2: Waves and Modern Physics 3 cr

(Lab Required) At the heart of modern communications, waves and oscillations are key to understanding the world around us from subatomic scales to biology, traffic flow, the stock market, climate change and the cosmos itself. Learn about the mysterious quantum world, the basis of the latest nanotechnology, where particles are waves and waves are particles. Explore Bohr's model of the atom and discover Heisenberg's Uncertainty Principle. This calculus based course addresses the underlying concepts for all modern science and engineering. This course, like Physics 1 (PHYS 1050), is intended for students considering a program in the physical sciences. Recommended for entry into the Honours programs (with a grade of "B"). May not be held for credit with PHYS 1071, the former PHYS 1410, the former PHYS 1420, or PHYS 2152.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: (PHYS 1050 or PHYS 1051) or (a grade of "B" or better in PHYS 1020 or PHYS 1021) and (one of MATH 1230, MATH 1500, MATH 1501, MATH 1510, MATH 1520, or the former MATH 1530). Pre- or co-requisite: one of MATH 1232, MATH 1700, MATH 1701, MATH 1690, MATH 1710, or the former MATH 1730.

**Equiv To:** PHYS 1071

**Mutually Exclusive:** PHYS 1410, PHYS 1420, PHYS 2152

**Attributes:** Science, Recommended Intro Courses

## PHYS 2010 Computational Modeling of Natural and Human-Created Systems 3 cr

This course uses computer simulations to explore emergent behavior in simple models of natural phenomena, traffic, financial systems, and human behavior. The goal of the course is to show how computational modeling can be applied to exciting interdisciplinary problems spanning a wide range of human knowledge, beyond what is normally considered to be physics.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: (one of COMP 1012, COMP 1013, COMP 1010 or COMP 1011) and (one of PHYS 1020, PHYS 1021, PHYS 1050, or PHYS 1051) and (one of MATH 1220, MATH 1300, MATH 1301, or the former MATH 1310) and (one of MATH 1230, MATH 1500, MATH 1501, MATH 1510, MATH 1520, the former MATH 1530, or MATH 1690).

**Attributes:** Science

**PHYS 2152 Modern Physics for Engineers 3 cr**

(Lab Required) An overview of topics in modern physics including wave particle duality, atomic structure and quantum mechanics. Elementary classical electromagnetic theory and wave theory are reviewed as an introduction to the modern physics concepts. For Engineering students only. May not be held with PHYS 1070 or PHYS 1071.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: a "C" or better in one of PHYS 1050, PHYS 1051; or a "B" or better in PHYS 1020 or PHYS 1021; and a "C" or better in one of MATH 1230, MATH 1500, MATH 1501, MATH 1510, MATH 1520; and a "C" or better in one of MATH 1232, MATH 1700, MATH 1701, MATH 1710 or MATH 1690. Prerequisite or concurrent requirement: MATH 2130.

**Equiv To:** PHYS 2250, PHYS 2251

**Mutually Exclusive:** PHYS 1070, PHYS 1071

**Attributes:** Science

**PHYS 2210 Understanding Electricity and Magnetism 3 cr**

An introduction ranging from its history to connections with real-world phenomena in engineering and biology, and common sense on the understanding of the phenomena. The student is carefully guided through mathematical derivations. Physics is used to develop the theory and the applications of such things as motors, radios, magnetic resonance imaging (MRI) systems and computers. May not be held with the former PHYS 2200, or the former PHYS 2201, PHYS 2600 or PHYS 2610.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: [(PHYS 1070 or PHYS 1071) or (a "C+" or better in both of (PHYS 1020 or PHYS 1021) and (PHYS 1030 or PHYS 1031))] and [one of MATH 1230, MATH 1500, MATH 1501, MATH 1510, MATH 1520]. Pre- or corequisite: [MATH 1200 or the former MATH 1201 or MATH 1240 or MATH 1241] and [one of MATH 1232, MATH 1690, MATH 1700, MATH 1701, MATH 1710].

**Mutually Exclusive:** PHYS 2200, PHYS 2201, PHYS 2600, PHYS 2610

**Attributes:** Science

**PHYS 2260 Optics 3 cr**

(Lab Required) A survey of refraction, reflection, simple lens systems and optical systems, dispersion, achromatism and an elementary treatment of diffraction, interference, and polarization. May not be held with PHYS 2261.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: [PHYS 1050 or PHYS 1051] or [a "C+" or better in PHYS 1020 or PHYS 1021] and [one of MATH 1230, MATH 1500, MATH 1501, MATH 1510, MATH 1520, or MATH 1690]. Pre- or corequisites: [one of PHYS 1070, PHYS 1071, PHYS 1030, PHYS 1031, or PHYS 2152] and [one of MATH 1210, MATH 1211, MATH 1220, MATH 1300, MATH 1301, or MATH 1310] and [one of MATH 1232, MATH 1700, MATH 1701, or MATH 1710].

**Equiv To:** PHYS 2261

**Attributes:** Science

**PHYS 2270 Introductory Physics for Life Sciences: Fundamentals and Applications 3 cr**

Physical topics with a relation to biology are discussed. Radiative transfer of energy, boundary layers, heat conduction, diffusion, mass transport, and the use of radioactive materials in biology are considered. May not be held with PHYS 2271 or PHYS 2272.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: (a grade of "C" or better in PHYS 1050 or PHYS 1051) or (a "C+" or better in PHYS 1020, or PHYS 1021) or permission of the department.

**Equiv To:** PHYS 2271

**Mutually Exclusive:** PHYS 2272

**Attributes:** Science

**PHYS 2272 Physics for Medicine & Biology 3 cr**

An intermediate course in physics with relevant applications to Medical and Biological Physics. The course will cover key topics in mechanics, fluid dynamics, exponential growth and decay, equilibrium and entropy, modeling of transport by drift and diffusion, and electricity and magnetism, as applied to the human condition; Linear and nonlinear feedback, regression and the Fourier series for signal and image analysis will also be covered. May not be held with PHYS 2270 or the former PHYS 2271.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: (one of PHYS 1070, PHYS 1071, or PHYS 2152) or (a grade of "C+" or better in one of PHYS 1030 or PHYS 1031) and (one of MATH 1232, MATH 1690, MATH 1700, MATH 1701, MATH 1710, or the former MATH 1730).

**Mutually Exclusive:** PHYS 2270, PHYS 2271

**Attributes:** Science

**PHYS 2350 Energy Sources: Physical Aspects 3 cr**

A detailed investigation of the physical aspects of energy production and utilization. Critical comparison of the various energy sources including solar, nuclear, fossil, and wind will be emphasized. The physics of energy collection, production, storage, and distribution will be discussed in the context of thermodynamics, radiation, solid state and nuclear physics.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: (a grade of "C" or better in one of PHYS 1070, PHYS 1071 or PHYS 2152) or (a "C+" or better in PHYS 1030 or PHYS 1031) or permission of the department.

**Mutually Exclusive:** PHYS 1303

**Attributes:** Science

**PHYS 2386 Introduction to Quantum Mechanics and Special Relativity 3 cr**

The first in a sequence of three courses on quantum mechanics, which also includes an introduction to the theory of special relativity. The topics covered include Einstein's postulates of special relativity, the Lorentz transformation, relativistic kinematics and dynamics and four-vectors, kinetic theory of gases, cavity radiation and normal modes, Planck's quantization postulate and the Schrodinger theory of quantum mechanics. Special emphasis is placed on the derivation of the time dependent and time independent Schrodinger equation and its solutions in one dimension. May not be held with the former PHYS 2380.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: (one of PHYS 1070, PHYS 1071 or PHYS 2152) or (a "C+" or better in PHYS 1030 or PHYS 1031) and (one of MATH 1232, MATH 1690, MATH 1700, MATH 1701, MATH 1710, or the former MATH 1730).

**Mutually Exclusive:** PHYS 2380

**Attributes:** Science

**PHYS 2390 Theoretical Physics 1 3 cr**

This course provides an introduction to the mathematics required for both the Honours and Major programs in Physics and Astronomy. Topics include series expansions, partial derivatives, vector calculus and integral theorems.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: PHYS 1050 or PHYS 1051, or a "C+" or better in PHYS 1020 or PHYS 1021; and one of MATH 1232, MATH 1690, MATH 1700, MATH 1701, MATH 1710. Pre- or Corequisite: one of PHYS 1070 or PHYS 1071 or PHYS 1030 or PHYS 1031.

**Attributes:** Science

**PHYS 2490 Theoretical Physics 2 3 cr**

This course provides a continuation of the introduction to the mathematics required for both the Honours and Major programs in Physics and Astronomy. Topics include Fourier series, differential equations, special functions, boundary value problems and transform methods.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: PHYS 2390.

**Mutually Exclusive:** PHYS 2496

**Attributes:** Science

**PHYS 2496 Mathematical Physics 1 3 cr**

This course provides a continuation of the mathematics required for both the Honours and Major programs in Physics and Astronomy. Topics include sequences and series, an introduction to complex numbers, special functions, ordinary differential equations, Fourier series and transforms, and an introduction to probability and statistics. May not be held with PHYS 2490.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: [PHYS 1050 or PHYS 1051] or [a "C+" or better in PHYS 1020 or PHYS 1021] and [one of MATH 1232, MATH 1690, MATH 1700, MATH 1701, or MATH 1710]. Pre- or corequisite: one of PHYS 1070, PHYS 1071, PHYS 1030, PHYS 1031, or PHYS 2152.

**Mutually Exclusive:** PHYS 2490

**Attributes:** Science

**PHYS 2600 Electromagnetic Field Theory 3 cr**

(Lab Required) Electric field, electric potential, Gauss' law, capacitors, dielectric materials, magnetic fields, Ampere's law, magnetic induction, magnetic materials, displacement current, integral form of Maxwell's equations. In addition to the lectures, the course includes a tutorial session of two hours per week. May not be held with PHYS 2200 or PHYS 2201.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: a "C" or better in one of PHYS 1070, PHYS 1071, or PHYS 2152, or a "C+" or better in PHYS 1030 or PHYS 1031; and a "C" or better in one of MATH 1232, MATH 1690, MATH 1700, MATH 1701, MATH 1710.

**Mutually Exclusive:** PHYS 2200, PHYS 2201, PHYS 2210

**Attributes:** Science

**PHYS 2610 Circuit Theory and Introductory Electronics 3 cr**

(Lab Required) Ohm's law, Kirchhoff's laws, DC circuit analysis, equivalent circuits, AC circuit analysis, complex impedance, RLC circuits, magnetic coupling, transformers, diodes and diode circuits. May not be held with PHYS 2200 or PHYS 2201.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: PHYS 2600.

**Mutually Exclusive:** PHYS 2200, PHYS 2201, PHYS 2210

**Attributes:** Science

**PHYS 2650 Classical Mechanics 1 3 cr**

The first in a sequence of two courses on intermediate to advanced level mechanics. Topics include inertial and non-inertial reference frames, energy, oscillations, dynamics of systems of particles, motion of a projectile with air resistance, planar motion of rigid bodies, as well as gravitation and central-force motion.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: [a "C" or better in one of PHYS 1070, PHYS 1071, or PHYS 2152] or [a "C+" or better in PHYS 1030 or PHYS 1031]. Pre- or corequisite: one of PHYS 2496, PHYS 2490 or MATH 3132.

**Attributes:** Science

**PHYS 3220 Medical Physics and Physiological Measurement 3 cr**

This course will introduce the core subject areas of Medical Physics, in particular the physics of physiology and of radiology. The mechanics of body systems and the theory, medical applications and safety issues relating to the production, use, detection and measurements of electromagnetic radiation (both ionizing and non-ionizing) will be included. It will also cover Medical imaging (Ultrasound, CT and MRI) and will provide the student with an understanding of the physics underlying neurological, audiological, respiratory and vascular function and measurements.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: (one of PHYS 1070, PHYS 1071 or PHYS 2152) or (a "C+" or better in PHYS 1030 or PHYS 1031) or permission of the department. PHYS 2270 or PHYS 2272 is recommended.

**Equiv To:** RTT 3220

**Attributes:** Science

**PHYS 3386 Quantum Mechanics 2 3 cr**

The second in the sequence of three courses on quantum mechanics which includes mathematical Hilbert space formalism, solutions of the Schrodinger equation in three dimensions with a special emphasis on central potentials, spin, angular momentum, ladder operators, Clebsch-Gordon coefficients and time-independent perturbation theory. May not be held with the former PHYS 3380.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: (PHYS 2386 or the former PHYS 2380) and (one of PHYS 2496, PHYS 2490, or MATH 3132). PHYS 3496 is recommended.

**Equiv To:** PHYS 3380

**Attributes:** Science

**PHYS 3430 Honours Physics Laboratory 6 cr**

Six hours per week. This is a hands-on course of experimental essentials of modern physics.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: one of PHYS 2260, PHYS 2261, PHYS 2610 or ECE 2160, or permission of the department.

**Attributes:** Science

**PHYS 3496 Mathematical Physics 2 3 cr**

This course provides a continuation of the mathematics required for both the Honours and Major programs in Physics and Astronomy. Topics include complex analysis, generalized coordinate systems, Sturm-Liouville theory and generalized orthogonal functions, partial differential equations, and applications in physics.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: [one of PHYS 2390, MATH 2720, MATH 2721, MATH 2130, MATH 2150, or MATH 2151] and one of PHYS 2496 or PHYS 2490. MATH 2090 or the former MATH 2300 is recommended.

**Attributes:** Science

**PHYS 3570 Physics of Materials 1 3 cr**

Introduction to the physics of materials. Solids within the elastic limit: stress and strain tensors, elastic constants. Liquids: continuity equation, Bernoulli, Euler and Navier-Stokes equations.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Pre- or corequisite: PHYS 3386 or the former PHYS 3380.

**Attributes:** Science

**PHYS 3630 Electro - and Magnetostatic Theory 3 cr**

Material covered will include electrostatics (i.e. Gauss' Law, Laplace and Poisson equations) and magnetostatics (Lorentz force, Maxwell equations) as well as the properties of electrostatic fields in matter and magnetism in materials.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: PHYS 2600 and (one of PHYS 2496, PHYS 2490, or MATH 3132) or permission of the department. PHYS 3496 is recommended.

**Attributes:** Science

**PHYS 3650 Classical Mechanics 2 3 cr**

The second in a sequence of two courses on intermediate to advanced level mechanics. Topics include calculus of variations, Lagrangian and Hamiltonian dynamics, rotational motion of rigid bodies in three dimensions, canonical equations using Poisson brackets, nonlinear oscillations and chaos, and coupled oscillations.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: PHYS 2650. Pre- or corequisite: one of PHYS 3496, PHYS 2490, or MATH 3132.

**Attributes:** Science

**PHYS 3670 Classical Thermodynamics 3 cr**

An introduction to the laws of classical equilibrium thermodynamics and their applications.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: one of PHYS 2496, PHYS 2490 or MATH 3132.

**Attributes:** Science

**PHYS 4010 General Relativity and Gravitation 3 cr**

The course briefly covers Newtonian gravity, special relativity and Minkowski space, before moving on to relativistic electrodynamics with the focus on the energy-momentum tensor, relativistic hydrodynamics, non-inertial reference frames and the principle of covariance and Einstein's field equations, linearized field equations and gravitational waves, as well as Schwarzschild's solution with the application to a static black hole.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: PHYS 3650 and (PHYS 3496 or PHYS 2490) or permission of the department. Pre- or corequisite: PHYS 4646 or the former PHYS 3640.

**Attributes:** Science

**PHYS 4250 Computational Physics 3 cr**

Application of numerical methods and programming skills to model a variety of physics problems on a computer. Topics include differential equations, boundary value and eigenvalue problems, special functions, and Monte Carlo methods, with examples from classical, quantum, and statistical mechanics.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: (one of COMP 1012, COMP 1013, COMP 1010, or COMP 1011) and (PHYS 3496 or PHYS 2490) or permission of the department.

**Attributes:** Science

**PHYS 4300 Topics in Physics 3 cr**

Topics will vary depending upon student needs and interests, and will include specialized topics not available in regular course offerings.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: PHYS 3386 or the former PHYS 3380, or permission of the department.

**Mutually Exclusive:** ASTR 4100, ASTR 4200

**Attributes:** Science

**PHYS 4350 The Physics of Fluids 3 cr**

The course covers basic fluid dynamics based on the Euler equations.

Topics include conservation laws; linear sound waves; instabilities; the generation of sound waves; linear and non-linear description of water waves including the Korteweg-de Vries equation, soliton solutions, and shock waves; elasticity and the stress tensor; Navier-Stokes equations and their solutions; the Hagen-Poiseuille law; Stokes' law and aerodynamics; attenuation of acoustic waves; non-linear acoustics; and the basic concepts of the description of turbulence including Kolmogorov's theory, correlation functions, and spectral tensors.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: PHYS 3496.

**Attributes:** Science

**PHYS 4360 Medical Radiation Physics 3 cr**

The relevant physics of the production and interaction of radiation beams used in both diagnostic and therapeutic medicine will be covered. Such beams included X- and g-rays, particle beams, visible and I.R. radiation, microwaves, and ultrasound.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: PHYS 3220 or the former PHYS 4560 or permission of the department.

**Attributes:** Science

**PHYS 4386 Quantum Mechanics 3 3 cr**

The third in the sequence of three courses on quantum mechanics which includes systems of identical particles, variational methods, time-dependent perturbation theory and scattering theory. May not be held with the former PHYS 4390.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: (PHYS 3386 or the former PHYS 3380) and (PHYS 3496 or PHYS 2490).

**Equiv To:** PHYS 4390

**Attributes:** Science

**PHYS 4400 Medical Imaging 3 cr**

Fundamental principles of image formation, analysis of the characteristics of medical images, parametric description of image quality; application to transmission radiography.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: PHYS 3220 or permission of the department.

**Attributes:** Science

**PHYS 4516 Introduction to Nuclear and Particle Physics 3 cr**

Bulk properties of the atomic nucleus; nuclear models, nuclear disintegration; alpha-decay, gamma transitions, and beta-decay; scattering formalism and experiments; evidence for quark structure and properties of the hadrons (neutrons, protons, mesons); basic introduction to QCD; basic intro to the weak interaction and neutrino physics; basic introduction to the standard model. May not be held with the former PHYS 4510.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: (PHYS 3386 or the former PHYS 3380) and (PHYS 4646 or the former PHYS 3640).

**Mutually Exclusive:** PHYS 4510

**Attributes:** Science



**PHYS 4520 Introduction to Solid State Physics 3 cr**

An introduction to the following topics as they relate to the properties of solids: crystal structure and lattice energy; lattice vibrations; specific heat; free-electron gas; electronic band structure; metals, semiconductors and insulators.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: (PHYS 3386 or the former PHYS 3380) and (PHYS 4680 or the former PHYS 3680).

**Attributes:** Science

**PHYS 4590 Advanced Optics 3 cr**

Light as a classical electromagnetic wave, optical fields in media, interference by wavefront and amplitude splitting, diffraction, diffraction theory of image formation, spatial filtering and image processing, coherence theory.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: (PHYS 2260 or PHYS 2261) and (PHYS 4646 or the former PHYS 3640).

**Attributes:** Science

**PHYS 4600 Lasers and Applications 3 cr**

Light and atoms: semi-classical theory, principles of laser operation and properties of laser light, polarization optics, Gaussian beam optics, laser spectroscopy.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: (PHYS 2260 or PHYS 2261) and (PHYS 3386 or the former PHYS 3380).

**Attributes:** Science

**PHYS 4620 Advanced Classical Mechanics 3 cr**

Canonical invariants and Lagrange and Poisson brackets. Hamilton-Jacobi theory, action-angle variables, normal modes of vibration.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: PHYS 3650 and PHYS 3496.

**Attributes:** Science

**PHYS 4630 Physics of Materials 2 3 cr**

Physics of materials beyond the elastic limit, emphasizing atomistic features. Structural aspects, crystal defects, plastic deformation, radiation damage, diffusion and dislocations.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: PHYS 3570.

**Attributes:** Science

**PHYS 4646 Electro - and Magnetodynamics and Special Relativity 3 cr**

Topics covered will include time dependent Maxwell's equations, Ohm's and Faraday's Law, electromagnetic waves, potential and fields, radiation, and special relativity including the Lorentz transformations. May not be held with the former PHYS 3640.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: PHYS 3630 or ECE 3590. Pre-or corequisite: one of PHYS 3496, PHYS 2490, or MATH 3132.

**Mutually Exclusive:** PHYS 3640

**Attributes:** Science

**PHYS 4676 Honours Thesis - Proposal and Preparation 3 cr**

For students in term 1 of their final year in Honours. The student will prepare a proposal for the undergraduate thesis and demonstrate the feasibility of the project under the supervision of a faculty member. The results of the study will be presented (in written and oral form) to an examining committee during the term. Both experimental and theoretical topics are acceptable. A grade of C (based on the presentations) is required to proceed to the next course which forms the final stage of the honours thesis. May not to be held with the former PHYS 4670 or the former PHYS 4672.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: permission of the thesis supervisor.

**Mutually Exclusive:** PHYS 4670, PHYS 4672

**Attributes:** Science

**PHYS 4678 Honours Thesis - Dissertation 3 cr**

For students in term 2 of their final year in Honours. The student will complete the work needed and produce an undergraduate thesis under the supervision of a faculty member. The grade will be based on the examining committee's evaluation of a progress report (presented mid-term) and an evaluation of the thesis manuscript and oral presentation at the end of term. Both experimental and theoretical topics are acceptable. May not be held with the former PHYS 4670, the former PHYS 4672, or the former PHYS 4674.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisite: permission of the department.

**Mutually Exclusive:** PHYS 4670, PHYS 4672, PHYS 4674

**Attributes:** Science

**PHYS 4680 Statistical Mechanics 3 cr**

Principles of statistical mechanics and their applications. Topics include phase space, Liouville and Poincare theorem, statistical ensembles, entropy, ideal classical gas, photon gas, Fermi gas, Bose-Einstein condensation, models of magnetism, and phase transitions. May not be held with the former PHYS 3680.

**PR/CR: A minimum grade of C is required unless otherwise indicated.**

Prerequisites: (PHYS 2386 or the former PHYS 2380) and PHYS 3670.

Pre- or corequisite: PHYS 3496 or PHYS 2490.

**Mutually Exclusive:** PHYS 3680

**Attributes:** Science