PHYSICS (PHY)

The following courses are offered by the Faculty of Science.

PHY 1112 Introduction to Computational Physics (3 units)
This course introduces students to the fundamentals of computational physics; no prior coding experience is required. Introduction to coding including data types, data structures and classes, operators, functions, control flow. Debugging and testing. Working with elementary math functions and scientific data, including storage, data visualization, data analysis and linear regression. Vector and matrix operations. Introduction to numerical methods in physics including differentiation, integration, solving ordinary differential equations, simple Monte Carlo techniques and optimization.
Course Component: Laboratory, Lecture
Prerequisites: MAT 1320, MAT 1341. MAT 1322 or MAT 1325 are corequisite to PHY 1112. Courses GNG 1106, ITI 1120, PHY 1112 cannot be combined for units.

PHY 1121 Fundamentals of Physics I (3 units)
Kinematics, reference frames, and relative motion. Newton's laws of motion, forces and fields. Work and energy. Impulse and momentum. Systems of several particles and rigid bodies. Rotational dynamics. Oscillatory motion. A first course intended primarily for students in the physical sciences and engineering. A familiarity with vector algebra and some understanding of calculus is assumed. An additional problem class of one hour per week is offered with the course. Includes a 3 hour lab in alternate weeks. Previously PHY 1101 and half of PHY 1201. Must register to PHY 1331 if 4U or OAC Physics not completed.
Course Component: Discussion Group, Laboratory, Lecture
Prerequisite: OAC or 4U Physics. MAT 1320 or MAT 1321 (preferred) or MAT 1327 or MAT 1330 is corequisite to PHY 1121. The courses PHY 1121, PHY 1124, PHY 1321, PHY 1331 cannot be combined for units.

PHY 1122 Fundamentals of Physics II (3 units)
Heat and thermodynamics. Hydrostatics and hydrodynamics. Geometrical optics. Wave theory, Physical optics. Electrostatics. Direct current circuits. A second course intended primarily for students in the physical sciences and engineering. A familiarity with vector algebra and some understanding of calculus is assumed. An additional problem class of one hour per week is offered with the course. Includes a 3 hour lab in alternate weeks. This course is normally a sequel to PHY 1121.
Course Component: Discussion Group, Laboratory, Lecture
Prerequisite: OAC or 4U Physics. MAT 1320 or MAT 1321 (preferred) or MAT 1327 or MAT 1330 is corequisite to PHY 1122. The courses PHY 1122, PHY 1124, PHY 1321, PHY 1322 or PHY 1331 cannot be combined for units.

PHY 1124 Fundamentals of Physics for Engineers (3 units)
Review of kinematics, reference frames and relative motion. Newton's laws of motion, forces, and fields. Work, energy and power. Oscillator motion. Electrostatics and Gauss' law. Magnetic fields and forces. Introduction to special relativity. This course is intended for students in electrical and computer engineering. An additional problem class of one hour per week is offered with the course. Includes a 3 hour lab in alternate weeks. Previously PHY 1104 and PHY 1304.
Course Component: Discussion Group, Laboratory, Lecture
Prerequisites: OAC or 4U Physics, MAT 1320 or MAT 1321. The courses PHY 1124, PHY 1121, PHY 1122, PHY 1321, PHY 1322, PHY 1331 cannot be combined for units. Must register to PHY 1331 if 4U or OAC Physics not completed.

PHY 1300 The Big Bang and Beyond (3 units)
Physics is all around us, from what we experience every day, to the technologies that have a major impact on our society. This course introduces students to some of the most important scientific breakthroughs and how they affect our lives - from fundamental concepts such as Big Bang theory and quantum theory, to technological breakthroughs such as medical imaging, determining the structure of DNA, and computer chips.
Course Component: Lecture
PHY 1300 cannot be combined for credits with PHY 1121, PHY 1122, PHY 1124, PHY 1321, PHY 1322, PHY 1331. No background in science or mathematics is required. This course cannot count as a Science optional course, but may be used as an elective.

PHY 1321 Principles of Physics I (3 units)
Kinematics and particle dynamics. Energy and work. Momentum and impulse. Rotational motion. Heat and thermodynamics. Fluid mechanics. A first course intended primarily for students in the life sciences. An additional problem class of one hour per week is offered with the course. Includes a 3 hour lab in alternate weeks. Previously PHY 1301 and half of PHY 1201. Must register to PHY 1331 if 4U or OAC Physics not completed.
Course Component: Discussion Group, Laboratory, Lecture
Prerequisite: OAC or 4U Physics. MAT 1320 or MAT 1321 or MAT 1327 or MAT 1330 is corequisite to PHY 1321. The courses PHY 1321, PHY 1121, PHY 1122, PHY 1124 or PHY 1331 cannot be combined for units.

PHY 1322 Principles of Physics II (3 units)
Electric field and potential. Capacitance. Electric current. DC electric circuits. Harmonic motion and waves. Optics. Introduction to modern physics: Atomic physics, Bohr model, photoelectric effect. A second course intended primarily for students in the life sciences. Familiarity with algebra and trigonometry is assumed, and some concepts from vector algebra and calculus are used. An additional problem class of one hour per week is offered with the course. Includes a 3 hour lab in alternate weeks. This course is normally a sequel to PHY 1321/1331. Includes a 3 hour lab in alternate weeks.
Course Component: Discussion Group, Laboratory, Lecture
Prerequisite: PHY 1321 or PHY 1331 or OAC or 4U Physics. MAT 1320 or MAT 1321 or MAT 1327 or MAT 1330 is corequisite to PHY 1322. The courses PHY 1322, PHY 1122, PHY 1124 cannot be combined for units.

PHY 1331 Principles of Physics I (3 units)
Kinematics and particle dynamics. Energy and work. Momentum and impulse. Rotational motion. Heat and thermodynamics. Fluid mechanics. A first course intended primarily for students in the life sciences who have not taken OAC or 4U Physics. A pre-lecture workshop of 1.5 hours per week will expose students to concepts from 4U Physics. An additional problem class of one hour per week is offered with the course. Includes a 3 hour lab in alternate weeks.
Course Component: Discussion Group, Laboratory, Lecture, Tutorial
MAT 1320 or MAT 1321 or MAT 1327 or MAT 1330 is corequisite to PHY 1331. The courses PHY 1331, PHY 1121, PHY 1122, PHY 1124, PHY 1321 cannot be combined for units. Must register to PHY 1331 if 4U or OAC physics not completed.

PHY 1512 Introduction à la physique numérique (3 crédits)
Ce cours initie les étudiants aux concepts fondamentaux de la physique numérique; aucune expérience en programmation n'est requise. Introduction à la programmation, incluant types et structures de données, classes, opérateurs, fonctions, structures de contrôle. Tests et correction des programmes. Travailler avec fonctions mathématiques élémentaires et données scientifiques, incluant stockage, visualisation, analyse des données et régression linéaire. Opérations vectorielles et matricielles. Introduction aux méthodes numériques en physique, incluant dérivée, intégration, résolution d'équations différentielles ordinaires, techniques simples de Monte Carlo et optimisation.
Volet : Laboratoire, Cours magistral
Préalables : MAT 1720, MAT 1741. Le cours MAT 1722 ou MAT 1725 est concomitant à PHY1512. Les cours GNG 1506, ITI 1520, PHY1512 ne peuvent être combinés pour l'obtention de crédits.

PHY 1521 Principes fondamentaux de physique I (3 crédits)
Systèmes référentiels, cinématique, lois de Newton. Travail et énergie. Champ de force, gravitation universelle, impulsion et quantité de mouvement, corps rigides. Dynamique de rotation et moment cinétique. L'oscillateur mécanique. Premier cours destiné aux étudiants qui s'orientent vers les sciences physiques ou le génie. On présuppose une connaissance des notions de calcul différentiel et d'algèbre des vecteurs. Une séance hebdomadaire supplémentaire d'une heure d'exercices accompagne ce cours. Comprend un laboratoire de 3 heures alternant chaque semaine. Les cours PHY1521, PHY1524, PHY1721, PHY1731 ne peuvent être combinés pour l'obtention de crédits. Vous devez vous inscrire au cours PHY1731 si cours 4U Physique non complété.
Volet : Groupe de discussion, Laboratoire, Cours magistral
Préalable : 4U ou CPO physique. Le cours MAT 1720 ou MAT 1721 (suggéré) ou MAT 1727 ou MAT 1730 est concomitant à PHY 1521.

PHY 1522 Principes fondamentaux de physique II (3 crédits)
Hydrostatique et hydrodynamique. Chaleur, thermodynamique. Optique géométrique et optique physique. Électrostatique, circuits en courant continu. Un second cours destiné aux étudiants qui s'orientent vers les sciences physiques ou le génie. On présuppose une connaissance des notions de calcul différentiel et d'algèbre des vecteurs. Une séance hebdomadaire supplémentaire d'une heure d'exercices accompagne ce cours. Comprend un laboratoire de 3 heures alternant chaque semaine. Ce cours est la suite normale de PHY 1521.
Volet : Groupe de discussion, Laboratoire, Cours magistral
Préalable : CPO ou 4U Physique. Le cours MAT 1720 ou MAT 1721 (suggéré) ou MAT 1727 ou MAT 1730 est concomitant à PHY 1522. Les cours PHY 1522, PHY 1524, PHY 1721, PHY 1722 ou PHY 1731 ne peuvent être combinés pour l'obtention de crédits.

PHY 1524 Principes fondamentaux de physique pour ingénieurs (3 crédits)
Revue de la cinématique, systèmes référentiels et mouvement relatif. Lois du mouvement de Newton, forces et champs. Travail, énergie et puissance. Mouvement oscillatoire. Électrostatique et loi de Gauss. Champ et force magnétiques. Introduction à la relativité restreinte. Cours destiné aux étudiants en génie informatique et électrique. Une séance hebdomadaire supplémentaire d'une heure d'exercices accompagne ce cours. Comprend un laboratoire de 3 heures alternant chaque semaine. Vous devez vous inscrire au cours PHY1731 si cours 4U ou CPO Physique non complété.
Volet : Groupe de discussion, Laboratoire, Cours magistral
Préalables : 4U ou CPO physique, MAT 1720 ou MAT 1721. Les cours PHY 1524, PHY 1521, PHY 1522, PHY 1721, PHY 1722, PHY 1731 ne peuvent être combinés pour l'obtention de crédits.

PHY 1700 Au-delà du Big Bang (3 crédits)
La physique est partout dans nos vies et gouverne plusieurs phénomènes familiers reliés aux technologies modernes. Ce cours d'introduction en physique aborde les grandes découvertes scientifiques et leurs conséquences - en passant par les concepts fondamentaux associés au Big Bang et à la physique quantique au décodage de l'information génétique contenu dans les molécules d'ADN, ainsi qu'aux découvertes en médecine nucléaire et dans le monde des semi-conducteurs. Ce cours ne peut pas être utilisé comme cours optionnel en sciences, mais il peut être utilisé comme cours au choix.
Volet : Cours magistral
PHY 1700 ne peut pas être combiné pour l'obtention de crédits avec PHY 1521, PHY 1522, PHY 1524, PHY 1703, PHY 1721, PHY 1722, PHY 1731.

PHY 1703 Physique et environnement (3 crédits)
Cours conçu pour le programme d'études environnementales. Ce cours introduit les concepts physiques fondamentaux utiles pour l'étude de l'impact de l'activité humaine sur l'environnement: principes de conservation, notion d'énergie, sources d'énergie; limite physique du rendement des transformations énergétiques; transport des contaminants; pollution sonore; énergie nucléaire, effets de la radioactivité et du rayonnement. Ce cours ne peut être crédité aux étudiants inscrits à la Faculté des sciences ou à la Faculté de génie.
Volet : Cours magistral

PHY 1721 Principes de physique I (3 crédits)
Cinématique et dynamique des particules. Énergie et travail. Quantité de mouvement et impulsion. Rotation des corps solides. Chaleur et thermodynamique. Mécanique des fluides. Cours à l'intention des étudiants qui se destinent à l'étude des sciences de la vie. Une séance hebdomadaire supplémentaire d'une heure d'exercices accompagne ce cours. Comprend un laboratoire de 3 heures alternant chaque semaine. Vous devez vous inscrire au cours PHY 1731 si cours 4U ou CPO PHY non complété.
Volet : Groupe de discussion, Laboratoire, Cours magistral
Préalable : 4U ou CPO PHY. Le cours MAT 1720 ou MAT 1721 ou MAT 1727 ou MAT 1730 est concomitant à PHY 1721. Les cours PHY1721 ne peut pas être combiné avec PHY1521, PHY 1522, PHY1524 ou PHY1731.

PHY 1722 Principes de physique II (3 crédits)
Champ et potentiel électriques. Condensateurs. Courant électrique et circuits DC. Mouvement harmonique simple et ondes. Optique. Initiation à la physique moderne: physique atomique, modèle de Bohr, effet photoélectrique. Un second cours à l'intention des étudiants qui se destinent à l'étude des sciences de la vie. On présuppose que l'étudiant possède des connaissances de trigonométrie et d'algèbre. On fait appel à des éléments d'algèbre vectorielle et de calcul infinitésimal. Une heure de séances de problèmes est offerte avec le cours. Comprend un laboratoire de 3 heures alternant chaque semaine. Ce cours est la suite normale de PHY 1721, PHY 1731.
Volet : Groupe de discussion, Laboratoire, Cours magistral
Préalable : PHY 1721 ou PHY 1731 ou CPO ou 4U Physique. Le cours MAT 1720 ou MAT 1721 ou MAT 1727 ou MAT 1730 est concomitant à PHY 1722. Les cours PHY 1722, PHY 1522, PHY 1524 ne peuvent être combinés pour l'obtention de crédits.

PHY 1731 Principes de physique I (3 crédits)
Cinématique et dynamique des particules. Énergie et travail. Quantité de mouvement et impulsion. Rotation des corps solides. Chaleur et thermodynamique. Mécanique des fluides. Cours à l'intention des étudiants qui se destinent à l'étude des sciences de la vie et qui n ont pas pris les cours CPO ou 4U Physique. Une période additionnelle hebdomadaire de 1.5 heures exposera les étudiants aux concepts de physique 4U. Une séance hebdomadaire supplémentaire d'une heure d'exercices accompagne aussi ce cours. Comprend un laboratoire de 3 heures alternant chaque semaine. Doit s'inscrire à PHY 1731 si cours 4U ou CPO physique non complété.
Volet : Groupe de discussion, Laboratoire, Cours magistral, Tutoriel
Le cours MAT 1720 ou MAT 1721 ou MAT 1727 ou MAT 1730 est concomitant à PHY 1731. Les cours PHY 1731, PHY 1521, PHY 1522, PHY 1524, PHY 1721 ne peuvent être combinés pour l'obtention de crédits.

PHY 2100 Fundamentals of Applied Physics III (3 units)
Course intended primarily for students not registered for an Honours degree in Physics. Introduction to electromagnetism, electromagnetic theory, atomic structure, nuclear physics, solid state and relativity. Cannot be taken for units by students who have already passed PHY 2323.
Course Component: Lecture
Prerequisite: PHY 1121 or PHY 1122 or PHY 1124 or PHY 1321 or PHY 1322 or PHY 1331.

PHY 2104 Introduction to Circuit Theory and Electronics (3 units)
Review of basic circuit elements. Kirchhoff's laws and analysis techniques: nodal, mesh, Thévenin and Norton equivalents, maximum power transfer theorem. Basic concepts of semiconductor physics, diodes, bipolar and field effect transistors. Operational amplifiers and their application, signal conversion. RC, RL and RLC circuits, alternating current circuit analysis, phasors, frequency response, Bode plots, filters. Noise sources, grounding problems, impedance mismatch.
Course Component: Laboratory, Lecture
Prerequisites: (PHY 1121, PHY 1122) or ((PHY 1321 or 1331), PHY 1322). The courses PHY 2104, PHY 2904, PHY 2906 cannot be combined for credit.

PHY 2300 How Things Work - Physics of Everyday Life (3 units)
This course explores the science underlying technology and the physics of everyday life. It will cover topics such as why we see rainbows, how airplanes fly, why microwave ovens heat up your food, why your phone battery doesn't last long enough, and how your computer (or the cloud) can store your entire music library. Each lecture will include a class demo followed by a revealing of the simple physics behind the observations. No background in science or mathematics is required.
Course Component: Lecture
Prerequisites: 18 university units. PHY1121 or PHY1122 cannot be combined for credits with PHY2300. This course cannot count as a Science optional course, but may be used as an elective.

PHY 2311 Waves and Optics (3 units)
Plane and spherical wave propagation, phase and group velocity, wave equation in one, two and three dimensions. Fermat's principle, matrix optics, aberrations. Polarization. Interference and diffraction. Lasers, detectors, introduction to fiber optics. (Derived from PHY 2310 and PHY 2337).
Course Component: Discussion Group, Laboratory, Lecture
Prerequisites: (PHY 1122 or PHY 1124 or PHY 1322), (MAT 1322 or MAT 1325 or MAT 1332).

PHY 2315 Optical System Design (3 units)
Introduction to the basic principles of optical system design. Geometrical and gaussian optics. Imaging instruments: telescope, microscope. Methods of optical system design: multi-element lens design, optimization, tolerances. Aberrations in imaging. Interferometers. Polarization optics: birefringence, polarizers, waveplates. Fourier and diffractive optics, spatial light modulators.
Course Component: Lecture
Prerequisite: PHY 2311.

PHY 2323 Electricity and Magnetism (3 units)
Review of vector analysis: gradient, divergence and curl. Electrostatics: Coulomb's law, electric field, Gauss's law, energy and potential, conductors, semiconductors and dielectrics, capacitance, Poisson's and Laplace's equations. Steady electric currents. Magnetostatics: magnetic fields and forces, Ampere's and Biot-Savart laws, Maxwell's equations, electromagnetic potentials.
Course Component: Discussion Group, Lecture
Prerequisites: (MAT 2121 or MAT 2122 or MAT 2322), (PHY 1124 or (PHY 1121, PHY 1122) or (PHY 1321, PHY 1322) or (PHY 1331 or PHY 1322)).

PHY 2325 Physics in Biology (3 units)
This course presents physical principles important to the operation of biological systems. Entropy, diffusion, cellular electricity, cellular motor forces, mechanical properties of the cell, and selected topics from radiation biophysics, biological oscillators and switches, sensory physics, biological waves, self organization, and biological complexity.
Course Component: Lecture
Prerequisites: (MAT 1322 or MAT 1325 or MAT 1332), (PHY 1122 or PHY 1321 or PHY 1331).

PHY 2333 Mechanics (3 units)
Newtonian mechanics. Central forces and celestial mechanics. Inertial forces and non-inertial frames. Rotational dynamics of a rigid body. Forced oscillations and resonance. Coupled oscillations and normal modes. Lagrangian and Hamiltonian formulations. (Derived from PHY 2330 and PHY 2337).
Course Component: Discussion Group, Lecture
Prerequisites: MAT 1341, (MAT 1322 or MAT 1325 or MAT 1332), (PHY 1121 or PHY 1321 or PHY 1331 or PHY 1124).

PHY 2361 Modern Physics (3 units)
Special theory of relativity. Quantum nature of light and matter. Schroedinger equation: one-dimensional potential problems. Elements of atomic structure; electron spin, exclusion principle.
Course Component: Laboratory, Lecture
Prerequisites: MAT 1341, (MAT 1322 or MAT 1325 or MAT 1332), (PHY 1124 or (PHY 1121, PHY 1122) or (PHY 1321, PHY 1322) or (PHY 1331, PHY 1322)).

PHY 2390 Astronomy (3 units)
The celestial sphere and the heliocentric model. Gravity and motion. Telescopes and detectors. Planets and the origin of the Solar System. The Sun, stars, the Milky Way and other galaxies. Black holes, cosmology, dark matter and dark energy.
Course Component: Lecture
Prerequisites: PHY 1121 or PHY 1122 or PHY 1321 or PHY 1331 or PHY 1124.

PHY 2500 Principes fondamentaux de physique appliquée III (3 crédits)
Cours destiné principalement aux étudiants qui ne sont pas inscrits dans un programme spécialisé de physique. Introduction à l'électromagnétisme, induction et courants alternatifs. Sujets d'intérêt en physique atomique, physique nucléaire, état solide et relativité. PHY 2500 ne peut pas être suivi par les étudiants qui ont déjà réussi le cours PHY 2723.
Volet : Cours magistral
Préalable : PHY 1521 ou PHY 1522 ou PHY 1524 ou PHY 1721 ou PHY 1722 ou PHY 1731.

PHY 2504 Introduction à la théorie des circuits et à l'électronique (3 crédits)
Revue des éléments de base des circuits. Lois de Kirchhoff et techniques d'analyse: nodale, maille, équivalents Thévenin et Norton, principe de maximisation du transfert de puissance. Concepts de base de la physique des semiconducteurs, diodes, transistors bipolaires et à effet de champ. Amplificateurs opérationnels et leurs applications, conversion de signal. Circuits RC, RL et RLC, analyse de circuits à courant alternatif, phaseurs, réponse en fréquence, diagrammes de Bode, filtres. Sources de bruit, problèmes de mise à terre, impédances mal adaptées.
Volet : Laboratoire, Cours magistral
Préalables: (PHY 1521, PHY 1522) ou ((PHY 1721 ou 1731), PHY 1722). Les cours PHY 2504, PHY 2904, PHY 2906 ne peuvent pas être combinés pour l'obtention de crédits.

PHY 2700 Comment fonctionnent les choses autour de nous - la physique de la vie quotidienne (3 crédits)
Ce cours explore la science sous-jacente à la technologie et à la physique de la vie quotidienne. Il couvrira des sujets tels que : pourquoi voit-on des arcs-en-ciel; comment volent les avions; pourquoi un four à micro-ondes chauffe votre nourriture; pourquoi la batterie de votre téléphone ne dure jamais assez longtemps; et comment votre ordinateur (ou le « nuage ») peut conserver toute votre collection de musique. Chaque cours inclura une démonstration en classe suivie d'une explication qui révélera la physique sous-jacente aux observations. Une formation préalable en sciences ou en mathématiques n'est pas nécessaire.
Volet : Cours magistral
Préalables: 18 crédits universitaires. PHY1521 ou PHY1522 ne peuvent être combinés pour l'obtention de crédits avec PHY2700. Ce cours ne peut pas être utilisé comme cours optionnel en sciences, mais il peut être utilisé comme cours au choix

PHY 2711 Ondes et optique (3 crédits)
Propagation d'ondes planes et sphériques, vitesse de phase et de groupe. Equation d'onde en une, deux et trois dimensions. Principe de Fermat, optique matricielle et aberrations. Polarisation. Interférence et diffraction. Lasers, introduction à l'optique des fibres. (Dérivé de PHY 2710 et PHY 2737).
Volet : Groupe de discussion, Laboratoire, Cours magistral
Préalables : (PHY 1522 ou PHY 1524 ou PHY 1722), (MAT 1722 ou MAT 1725 ou MAT 1732).

PHY 2715 Conception de systèmes optiques (3 crédits)
Introduction aux principes de base de la conception de systèmes optiques. Optique géométrique et gaussienne. Formation d'image et instruments: télescope, microscope. Méthodes de conception de systèmes optiques: lentilles à éléments multiples, optimisation, tolérances. Aberrations dans la formation d'image. Interféromètres. Polarisation optique: biréfringence, polariseurs, lames retardatrices. Optique de Fourier et diffraction, modulation spatiale de faisceaux lumineux.
Volet : Cours magistral
Préalable: PHY 2711.

PHY 2723 Électricité et magnétisme (3 crédits)
Revue d'analyse vectorielle: gradient, divergence et rotationnel. Électrostatique: loi de Coulomb, champ électrique, loi de Gauss, énergie et potentiel, conducteurs, semiconducteurs et diélectriques, capacité, équations de Poisson et de Laplace. Courant électrique stationnaire. Magnétostatique: champs et forces magnétiques, lois d'Ampère et de Biot-Savart, matériaux magnétiques. Champs dépendant du temps: loi de Faraday, équations de Maxwell, potentiels électromagnétiques.
Volet : Groupe de discussion, Cours magistral
Préalables : (MAT 2521 ou MAT 2522 ou MAT 2722), (PHY 1524 or (PHY 1521, PHY 1522) ou (PHY 1721, PHY 1722) ou (PHY 1731 ou PHY 1722)).

PHY 2725 La physique en biologie (3 crédits)
Ce cours présente des principes physiques importants pour l'opération de systèmes biologiques. Entropie, diffusion, forces motrices cellulaires, propriétés mécaniques des cellules, et sujets choisis parmi les suivants: radiation en biophysique, oscillateurs et interrupteurs biologiques, la physique des sens, ondes biologiques, auto-organisation, et complexité biologique.
Volet : Cours magistral
Préalables : (MAT 1722 ou MAT 1725 ou MAT 1732), (PHY 1522 ou PHY 1721 ou PHY 1731).

PHY 2733 Mécanique (3 crédits)
Mécanique de Newton. Forces centrales et mécanique céleste. Systèmes non-inertiels et forces inertielles. Dynamique de la rotation des corps rigides. Oscillations forcées et résonance. Oscillations couplées et modes normaux. Formulation de Lagrange et de Hamilton. (Dérivé de PHY 2730 et PHY 2737).
Volet : Groupe de discussion, Cours magistral
Préalables : MAT 1741, (MAT 1722 ou MAT 1725 ou MAT 1732), (PHY 1521 ou PHY 1721 ou PHY 1731 ou PHY 1524).

PHY 2761 Physique moderne (3 crédits)
La théorie de la relativité restreinte. Nature quantique de la lumière et de la matière. Équation de Schroedinger: problèmes à une dimension. Éléments de la structure atomique; spin de l'électron, principe d'exclusion.
Volet : Laboratoire, Cours magistral
Préalables : MAT 1741, (MAT 1722 ou MAT 1725 ou MAT 1732), (PHY 1524 ou (PHY 1521, PHY 1522) ou (PHY 1721, PHY 1722) ou (PHY 1722, PHY 1731)).

PHY 2790 Astronomie (3 crédits)
La sphère céleste et le modèle héliocentrique. Gravité et mouvement. Télescopes et détecteurs. Planètes et origine du système solaire. Le soleil, les étoiles, la Voie lactée et autres galaxies. Trous noirs, cosmologie, matière sombre et énergie sombre.
Volet : Cours magistral
Préalables : PHY 1521 ou PHY 1522 ou PHY 1721 ou PHY 1731 ou PHY 1524

PHY 2900 X - Projets créatifs / X - Creative Projects (3 crédits / 3 units)
Les étudiants proposeront et développeront un projet qu'ils auront conçu. L'accent sera mis sur le processus créatif et itératif relié à l'élaboration de projet et au prototypage. Les étudiants acquerront des connaissances en conception, en réalisation et en gestion de projets. De plus, ils bénéficieront d'une expérience pratique avec les microcontrôleurs, le codage, la conception de circuits de base, les capteurs, le prototypage rapide, la modélisation 3D et les technologies de fabrication digitales telles que les imprimantes 3D et les découpeurs au laser. / Students will propose and develop a project of their own design. Emphasis will be placed on the creative and iterative process of project development and prototyping. Students will learn skills in project design, execution and management, as well as hands-on experience with microcontrollers, coding, simple circuit design, sensors, rapid prototyping, 3D modelling, and digital fabrication technologies such as 3D printers and laser cutters.
Volet / Course Component: Laboratoire / Laboratory
Préalables : (MAT 1720 ou MAT 1721 ou MAT 1727 or MAT 1730), (PHY1521 ou PHY 1522 ou PHY1524 ou PHY 1721 ou PHY1722 ou PHY 1731). Cours contingenté. / Prerequisites: (MAT 1320 or MAT 1321 or MAT 1327 or MAT 1330), (PHY 1121 or PHY 1122 or PHY 1124 or PHY 1321 or PHY 1322 or PHY 1331). Limited enrolment.

PHY 2904 Travaux pratiques en physique / Practical Physics (3 crédits / 3 units)
Cours de deuxième année pour les étudiants inscrits en physique ou en physique-mathématiques et approprié pour les étudiants inscrits en mathématiques-science. Travaux pratiques sur des sujets de physique classique et moderne. Antérieurement PHY 2004. / A second-year course for students registered for physics or physics-mathematics degree. Also suitable for a math-science degree. Laboratory experiments in both classical physics and modern physics. Previously PHY 2004.
Volet / Course Component: Laboratoire / Laboratory
Préalables : PHY 1731 ou (PHY 1521, PHY 1522) ou (PHY 1721 ou PHY 1722). Les cours PHY 2904, PHY 2906 ne peuvent être combinés pour l'obtention de units.

PHY 29041 Travaux pratiques en physique (Partie 1 de 2) / Practical Physics (Part 1 of 2)
A second-year course for students registered for physics or physics-mathematics degree. Also suitable for a math-science degree. Laboratory experiments in both classical physics and modern physics. Previously PHY 2004. (Partie 1 de 2) / A second-year course for students registered for physics or physics-mathematics degree. Also suitable for a math-science degree. Laboratory experiments in both classical physics and modern physics. Previously PHY 2004. (Part 1 of 2)
Volet / Course Component: Laboratoire / Laboratory
Préalables : PHY 1731 ou (PHY 1521, PHY 1522) ou (PHY 1721 ou PHY 1722). Les cours PHY 2904, PHY 2906 ne peuvent être combinés pour l'obtention de units.

PHY 29042 Travaux pratiques en physique (Partie 2 de 2) / Practical Physics (Part 2 of 2) (3 crédits / 3 units)
A second-year course for students registered for physics or physics-mathematics degree. Also suitable for a math-science degree. Laboratory experiments in both classical physics and modern physics. Previously PHY 2004. (Partie 2 de 2) / A second-year course for students registered for physics or physics-mathematics degree. Also suitable for a math-science degree. Laboratory experiments in both classical physics and modern physics. Previously PHY 2004. (Part 2 of 2)
Volet / Course Component: Laboratoire / Laboratory
Préalable : PHY 29041 / Prerequisite: PHY 29041

PHY 2906 Laboratoire de physique / Physics Laboratory (3 crédits / 3 units)
Expérience en électricité, magnétisme, physique moderne et optique pour les étudiants qui ne sont pas inscrits en physique. Antérieurement PHY 2206. / Experiments in electricity, magnetism, modern physics and optics for students not registered for a degree in Physics. Previously PHY 2206.
Volet / Course Component: Laboratoire / Laboratory
Préalables : PHY 1524 ou (PHY 1521, PHY 1522) ou (PHY 1721 ou PHY 1722) ou (PHY 1722, PHY 1731). Les cours PHY 2904, PHY 2906 ne peuvent être combinés pour l'obtention de crédits. / Prerequisites: PHY 1124 or (PHY 1121, PHY 1122) or (PHY 1321, PHY 1322) or (PHY 1322, PHY 1331). The courses PHY 2904, PHY 2906 cannot be combined for units.

PHY 29061 Laboratoire de physique (Partie 1 de 2) / Physics Laboratory (Part 1 of 2)
Expérience en électricité, magnétisme, physique moderne et optique pour les étudiants qui ne sont pas inscrits en physique. Antérieurement PHY 2206. (Partie 1 de 2) / Experiments in electricity, magnetism, modern physics and optics for students not registered for a degree in Physics. Previously PHY 2206. (Part 1 of 2)
Volet / Course Component: Laboratoire / Laboratory
Préalables : PHY 1524 ou (PHY 1521, PHY 1522) ou (PHY 1721 ou PHY 1722) ou (PHY 1722, PHY 1731). Les cours PHY 2904, PHY 2906 ne peuvent être combinés pour l'obtention de crédits. / Prerequisites: PHY 1124 or (PHY 1121, PHY 1122) or (PHY 1321, PHY 1322) or (PHY 1322, PHY 1331). The courses PHY 2904, PHY 2906 cannot be combined for units.

PHY 29062 Laboratoire de physique (Partie 2 de 2) / Physics Laboratory (Part 2 of 2) (3 crédits / 3 units)
Expérience en électricité, magnétisme, physique moderne et optique pour les étudiants qui ne sont pas inscrits en physique. Antérieurement PHY 2206. (Partie 2 de 2) / Experiments in electricity, magnetism, modern physics and optics for students not registered for a degree in Physics. Previously PHY 2206. (Part 2 of 2)
Volet / Course Component: Laboratoire / Laboratory
Préalable : PHY 29061 / Prerequisite: PHY 29061

PHY 3310 Photonics Measurement Techniques (3 units)
Basic working principles of lasers and detectors. Optical power, wavelength and frequency measurement using fibre-based Mach-Zehnder, Michelson and Fabry-Pérot interferometers and optical spectrum analyzer. Homodyne and heterodyne measurements of optical signal bandwidth. Time domain signal analysis by digital oscilloscope and pulse measurement techniques.
Course Component: Laboratory, Lecture
Prerequisites: PHY 2311, (PHY 2904 or PHY 2104).

PHY 3320 Electromagnetic Theory (3 units)
Foundations of Maxwell's equations. Propagation in different isotropic media: non-absorbing and non-conducting, absorbing but non-conducting, metallic. Energy contained in an electromagnetic wave. Poynting vector. Skin effect. Theoretical electrodynamics: invariance properties of Maxwell's equations, moving charges, radiation.
Course Component: Lecture
Prerequisite: PHY 2323.

PHY 3325 Introduction to Molecular Biophysics (3 units)
Physical properties of biological macromolecules and macromolecular assemblies. Structure, conformation, mechanics, and dynamics of biopolymers (proteins, nucleic acids, polysaccharides, glycoproteins, and proteoglycans) in solution; physics of biopolymer folding and complex formation; assembly of lipids and proteins into higher order structures; experimental methods for characterizing biological macromolecules.
Course Component: Lecture
Prerequisite: PHY 2325.

PHY 3341 Theoretical Physics (3 units)
Elements of the theory of finite and infinite dimensional vector spaces: Applications to a variety of physical problems of the concepts of linear mappings, eigenvalue problems, the delta function, orthogonal polynomials, Fourier series and Fourier transforms. Complex analysis: Laurent series and calculus of residues. Partial differential equations and boundary value problems illustrated with solutions of the wave and diffusion equations.
Course Component: Lecture
Prerequisites: PHY 2323, PHY 2333, (MAT 2324 or MAT 2384).

PHY 3350 Thermodynamics (3 units)
Equilibrium and state variables. Laws of thermodynamics. Thermodynamic potentials and chemical potential. Phase equilibrium and Gibbs phase rule. Microstates and entropy. Ensemble theory: microcanonical, canonical and grand canonical ensembles.
Course Component: Lecture
Prerequisite: PHY 2361.

PHY 3355 Statistical Thermodynamics (3 units)
Application of Boltzmann statistics: ideal gas, paramagnetism, lattice vibrations. Quantum statistics: ideal gas of fermions, ideal gas of bosons, black-body radiation. Real gases. Phase transitions. Transport processes.
Course Component: Lecture
Prerequisite: PHY 3350.

PHY 3370 Introductory Quantum Mechanics (3 units)
Wave description of particles. Mathematical background and postulates. Operators. Eigenstates. Schroedinger equation. Harmonic oscillator. Central potential, orbital angular momentum and hydrogen atom. Stationary perturbation theory.
Course Component: Lecture
Prerequisites: PHY 2333, PHY 2311, PHY 2361. PHY 3341 is corequisite to PHY 3370.

PHY 3380 Physics of the Earth (3 units)
Overview of geophysics. Earth structure: earthquakes as an energy source, seismic energy propagation, seismometers and seismic networks, inferring 1-D and 3-D Earth structure from seismic energy travel times. Earth dynamics: heat sources, surface heat flow measurements, convection and conduction of heat in the solid Earth, viscous flow of rocks, Rayleigh number, thermal boundary layers, mantle convection and plate tectonics. Large-scale Earth structure and dynamics: a synthesis.
Course Component: Lecture
Prerequisites: PHY 2311, ((PHY 1121, PHY 1122) or (PHY 1321, PHY 1322) or (PHY 1331, PHY 1322)).

PHY 3710 Techniques de mesure en photonique (3 crédits)
Principes de base des lasers et détecteurs. Mesure de puissance, longueur d'onde et fréquence à l'aide d'interféromètres à fibre optique de Mach-Zehnder, de Michelson et de Fabry-Pérot et de l'analyseur de spectre optique. Mesure homodyne et hétérodyne de largeur de bande de signaux. Analyse temporelle de signaux optiques à l'aide de l'oscilloscope et autres techniques.
Volet : Laboratoire, Cours magistral
Préalables: PHY 2711, (PHY 2904 ou PHY 2504).

PHY 3720 Théorie électromagnétique (3 crédits)
Fondements des équations de Maxwell. Propagation en milieux isotropes: sans absorption ni conduction, avec absorption mais sans conduction, métallique. Énergie contenue dans une onde électromagnétique. Vecteur de Poynting. Effet de peau. Électrodynamique théorique: propriétés d'invariance des équations de Maxwell, charges en mouvement, rayonnement.
Volet : Cours magistral
Préalable : PHY 2723.

PHY 3725 Introduction à la biophysique moléculaire (3 crédits)
Propriétés physiques des macromolécules et des structures supra-moléculaires de nature biologique. Structure, conformation, propriétés mécaniques et dynamiques de biopolymères en solution (protéines, acides nucléiques, polysaccharides, glycoprotéines et protéoglycanes); repliement des protéines et formation de complexes; assemblage de lipides et protéines en structures d'ordre supérieur; méthodes expérimentales de caractérisation des macromolécules biologiques.
Volet : Cours magistral
Préalable : PHY 2725.

PHY 3741 Physique théorique (3 crédits)
Éléments de la théorie des espaces vectoriels de dimension finie et infinie: Applications à la physique des concepts de transformations linéaires, de problèmes aux valeurs propres, de fonction delta, de polynômes orthogonaux, des séries et transformées de Fourier. Analyse complexe: Séries de Laurent et calcul des résidus. Équations aux dérivées partielles et problèmes aux conditions limites avec applications à l'équation d'onde et de diffusion.
Volet : Cours magistral
Préalables : PHY 2723, PHY 2733, (MAT 2724 ou MAT 2784).

PHY 3750 Thermodynamique (3 crédits)
Variables d'état et équilibre. Lois de la thermodynamique. Potentiels thermodynamiques et potentiel chimique. Équilibre des phases et règle des phases de Gibbs. Microétats et entropie. Théorie des ensembles: ensembles microcanonique, canonique et grand canonique.
Volet : Cours magistral
Préalable : PHY 2761.

PHY 3755 Thermodynamique statistique (3 crédits)
Application de la statistique de Boltzmann: gaz idéal, paramagnétisme, vibrations de réseaux. Statistique quantique: gaz idéal de fermions, gaz idéal de bosons, rayonnement du corps noir. Gas réels. Transitions de phase. Processus de transport.
Volet : Cours magistral
Préalable : PHY 3750.

PHY 3770 Introduction à la mécanique quantique (3 crédits)
Description ondulatoire des particules. Outils mathématiques et postulats. Opérateurs. États propres. Équation de Schroedinger. Oscillateur harmonique. Potentiel central, moment cinétique orbital et atome d'hydrogène. Perturbations stationnaires.
Volet : Cours magistral
Préalables : PHY 2733, PHY 2711, PHY 2761. PHY 3741 est concomitant à PHY 3770.

PHY 3902 Laboratoire de physique et de physique appliquée I / Physics and Applied Physics Laboratory I (3 crédits / 3 units)
Cours de laboratoire pour les étudiants de physique, physique-mathématiques, physique-option physique biologique, physique-option photonique et majeure en physique. Acquisition de données et conception d'expériences scientifiques. Capteurs et actionneurs. Mesures électroniques. Système de commande à rétroaction. Propriétés de matériaux et leurs variations avec la température. Expériences d'optique. Analyse de données expérimentales. Programmation de microcontrôleurs. Antérieurement PHY3901. / Laboratory course for students in the physics, physics-mathematics, physics-biological physics option, physics-photonics options, major in physics. Data acquisition and experimental setup design. Using sensors and actuators. Electrical measurements. Feedback control systems. Properties of materials and their dependence on temperature. Optics experiments. Analysis of experimental data. Programming microcontrollers. Previously PHY3901.
Volet / Course Component: Laboratoire / Laboratory
Préalable : PHY 2504 ou PHY 2904. / Prerequisite: PHY 2104 or PHY 2904.

PHY 3903 Questions contemporaines en physique / Contemporary Issues in Physics (2 crédits / 2 units)
Discussions d'un choix de sujets et de méthodes en physique contemporaine avec présentations orale et écrite par les étudiants. Introduction à Maple ou Mathematica. / Discussions on contemporary topics and methods in physics, including oral and written presentations. An introduction to Maple or Mathematica.
Volet / Course Component: Cours magistral / Lecture
Préalable : 12 crédits en physique au niveau 2000. / Prerequisite: 12 credits in physics at the 2000-level.

PHY 3904 Laboratoire de physique et de physique appliquée II / Physics and Applied Physics Laboratory II (3 crédits / 3 units)
Cours de laboratoire pour les étudiants des programmes de physique et physique-option physique biologique. Par des expériences de nature relativement plus complexes sur divers sujets de la physique classique et contemporaine, ce cours initie l'étudiant aux techniques expérimentales plus poussées et au travail de laboratoire indépendant. Utilisation de micro-ordinateurs pour l'acquisition et l'analyse des données. Antérieurement PHY3905. / Laboratory for students in the physics and physics-biological physics option programs. Through more complex experiments on various topics in classical and modern physics, students will focus on advanced experimental techniques and independent laboratory work. Use of microcomputers for data acquisition and analysis. Previously PHY3905.
Volet / Course Component: Laboratoire / Laboratory
Préalable : PHY 3902. / Prerequisite: PHY 3902.

PHY 4006 Projet de recherche en physique / Physics Research Project (6 crédits / 6 units)
L'étudiant travaillera sur un projet de recherche en physique approuvé, sous la supervision d'un professeur du département durant deux trimestres consécutifs. L'étudiant soumettra des rapports écrits et fera une présentation orale. / The student will work on an approved research project in physics under the supervision of a professor in the Department for two consecutive terms. Written reports and an oral presentation are required.
Volet / Course Component: Recherche / Research
Préalables: 12 crédits de cours en physique (PHY) de niveau 3000 et une MPC minimale de 5.00. Antérieurement PHY 4005. Les cours PHY 4906 et PHY 4006 ne peuvent être combinés pour l'obtention de crédits. Permission du Département. / Prerequisite: 12 course units in physics (PHY) at the 3000 level with a minimum CGPA of 5.00. Previously PHY 4005.The courses PHY 4906 and PHY 4006 cannot be combined for credits. Permission of the Department.

PHY 40061 Projet de recherche en physique (Partie 1 de 2) / Physics Research Project (Part 1 of 2)
L'étudiant travaillera sur un projet de recherche en physique approuvé, sous la supervision d'un professeur du département durant deux trimestres consécutifs. L'étudiant soumettra des rapports écrits et fera une présentation orale. / The student will work on an approved research project in physics under the supervision of a professor in the Department for two consecutive terms. Written reports and an oral presentation are required.
Volet / Course Component: Recherche / Research
Préalables: 12 crédits de cours en physique (PHY) de niveau 3000 et une MPC minimale de 5.00. Antérieurement PHY 4005. Les cours PHY 4906 et PHY 4006 ne peuvent être combinés pour l'obtention de crédits. Permission du Département. / Prerequisite: 12 course units in physics (PHY) at the 3000 level with a minimum CGPA of 5.00. Previously PHY 4005.The courses PHY 4906 and PHY 4006 cannot be combined for credits. Permission of the Department.

PHY 40062 Projet de recherche en physique (Partie 2 de 2) / Physics Research Project (Part 2 of 2) (6 crédits / 6 units)
L'étudiant travaillera sur un projet de recherche en physique approuvé, sous la supervision d'un professeur du département durant deux trimestres consécutifs. L'étudiant soumettra des rapports écrits et fera une présentation orale. / The student will work on an approved research project in physics under the supervision of a professor in the Department for two consecutive terms. Written reports and an oral presentation are required.
Volet / Course Component: Recherche / Research
Préalable PHY 40061. Antérieurement PHY 4005. / Prerequisite: PHY40061. Previously PHY 4005.

PHY 4140 Computational Physics: Deterministic Methods (3 units)
Deterministic numerical methods in physics. Numerical solutions of Newton's, Maxwell's and Schrodinger's equations. Molecular dynamics. Non-Linear dynamics. Numerical solutions of partial differential equations in physics. Finite elements. Previously PHY 4340.
Course Component: Laboratory, Lecture
Prerequisites: PHY 2333, (PHY 2361 or CHM 3373), (MAT 2384 or MAT 2324).

PHY 4141 Computational Physics: Stochastic Methods (3 units)
Interpolation, regression and modeling. Random number generation. Monte Carlo methods. Simulations in thermo-statistics. Fractals, percolation, cellular automata. Stochastic numerical methods. Previously PHY 4341.
Course Component: Laboratory, Lecture
Prerequisites: PHY 2333, (MAT 2384 or MAT 2324), (CHM 3373 or (PHY 2361, PHY 3350)).

PHY 4311 Introduction to Photonics - Lasers (3 units)
Introduction to laser physics including spontaneous and stimulated emission (Einstein's A and B coefficients), basic operation of lasers, linear and nonlinear light-matter interaction, dispersion and its control, longitudinal and transverse modes of a resonator, mode-locking, beam propagation.
Course Component: Lecture
Prerequisites: PHY 2311, PHY 2323. PHY 3370 is corequisite to PHY 4311. The courses PHY 4311, PHY 4310 cannot be combined for units.

PHY 4320 Introduction to Quantum Optics (3 units)
Classical, semi-classical and quantum theory of light-matter interaction. Dissipation and decoherence. Classical and quantum coherence functions, beam splitters and interferometers; non-classical light. Entanglement and quantum information.
Course Component: Lecture
Prerequisite: PHY 3370. PHY 3320 is corequisite to PHY 4320.

PHY 4322 Biological Physics (3 units)
Biological phenomena studied using techniques of physics. Key components of cells. Physical concepts relevant to cellular phenomena: Brownian dynamics, fluids, suspensions, entropy driven phenomena, chemical forces and self assembly. Biological molecules. Enzymes. Molecular motors. Nerve impulses.
Course Component: Lecture
Prerequisite: PHY 3325 or corequisite: PHY 3355.

PHY 4324 Energy Technologies (3 units)
Principles of energy generation and interconversion. The major current and likely future technologies used for electricity generation, transportation, and storage along with the economics of choosing between technologies. Topics include fossil fuels and renewable technologies, with attention to the thermodynamic limits of each process.
Course Component: Lecture
Prerequisites: PHY 2323, PHY 3350.

PHY 4327 Applications of Integrated Circuits in Physics (3 units)
A course designed to introduce students having no formal background of electronics to the use of integrated circuits in designing laboratory apparatus. Both digital and analogue circuits will be covered. Topics are chosen from counters, gates, wave-shaping, microcomputers, D/A and A/D conversion, op amps, filters, lock-in amplifiers, and phase locked loops. This course is offered in alternate years.
Course Component: Laboratory, Lecture
Prerequisites: PHY 3902, PHY 3904.

PHY 4330 Advanced Dynamics (3 units)
Advanced mechanics: Lagrangian and Hamiltonian formulations; canonical transformations: Hamilton-Jacobi theory. Relativity: Lorentz transformation; tensor analysis; relativistic classical mechanics.
Course Component: Lecture
Prerequisites: PHY 2333, PHY 2361.

PHY 4335 Physics of Continuous Media (3 units)
Conservation laws in continuous media and tensor notation. Elasticity theory: Hooke's law, stress-strain relations, sound waves in solids. Hydrodynamics: incompressible flows, Navier-Stokes equation, sound wave in fluids, shock waves. Elementary plasma physics: magnetohydrodynamics, plasma oscillations, Landau damping.
Course Component: Lecture
Prerequisites: PHY 2323, PHY 2333, PHY 3350.

PHY 4346 General Relativity (3 units)
An introduction to the mathematical techniques and experimental tests of the general theory of relativity. This course is offered in alternate years.
Course Component: Lecture
Prerequisites: PHY 3341, PHY 2361.

PHY 4361 Applied Nuclear Physics (3 units)
Review of basic nuclear concepts. Semi-empirical mass formula. Nuclear fission. Controlled chain reactions. Types of nuclear reactors. Breeder systems. The advantages and disadvantages of nuclear power. Nuclear fusion. Possible fusion reactions. Lawson criterion. Analysis of possible fusion power systems. Problems associated with practical fusion systems. Radioactive dating techniques. Selected other topics. This course is offered in alternate years.
Course Component: Lecture
Prerequisite: PHY 2361.

PHY 4362 Subatomic Physics I (3 units)
The passage of radiations through matter. Nuclear structure and systematics. Alpha decay. Beta decay. Two-nucleon interaction. Introduction to elementary particles.
Course Component: Lecture
Prerequisite: PHY 2361. PHY 3370 is corequisite to PHY 4362.

PHY 4368 Subatomic Physics II (3 units)
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.
Course Component: Lecture
Prerequisite: PHY 4362.

PHY 4370 Quantum Mechanics (3 units)
Electron spin. Coupling of angular momentum. Time-dependent perturbation theory. Systems of identical particles: bosons and fermions. Scattering theory.
Course Component: Lecture
Prerequisite: PHY 3370.

PHY 4375 Atomic, Molecular and Optical Physics (3 units)
Introduction to relevant elements of angular momentum, group theory, and techniques of approximation related to atomic and molecular physics. Atomic spectra and structure. Detailed discussion of electronic, vibrational and rotational structure of molecules . Molecular spectroscopy including high resolution methods. Electric and magnetic properties of atoms and molecules.
Course Component: Lecture
Prerequisite: PHY 3370. PHY 4370 is corequisite to PHY 4375.

PHY 4382 Introduction to Solid State Physics (3 units)
Crystal structure and its experimental determination. Cohesion in different solids. Crystal vibrations and thermal properties of solids. The Drude and Sommerfeld theories of metals. Energy bands. Semi-conductor crystals.
Course Component: Lecture
Prerequisite: PHY 2361. PHY 3350 is corequisite to PHY 4382.

PHY 4385 Solid State Physics (3 units)
Methods of energy band calculation. Phonons. Electron-electron interaction. Electron-phonon coupling. Electron states in defects. Optical properties of solids. Magnetism. Basic theory of superconductivity.
Course Component: Lecture
Prerequisite: PHY 4382.

PHY 4387 Physics of Materials (3 units)
Microscopic characteristics related to the physical properties of materials. Materials families: metals and alloys, ceramics, polymers and plastics, composites, layered materials, ionic solids, molecular solids etc. Specific materials groups. Equilibrium phase diagrams and their relation to microstructure and kinetics. Experimental methods of characterization. Interactions and reactions.
Course Component: Lecture
Prerequisite: PHY 4382.

PHY 4390 Selected Topics in Physics (3 units)
Selected topics in advanced Physics.
Course Component: Lecture

PHY 4395 Astrophysics (3 units)
Physical properties of stars. Stellar spectra and H-R diagram. Continuous radiation from stars. Line identification. Stellar interiors. Stellar evolution. White dwarfs. Galaxies. Redshifts. Radio sources. Quasi-stellar objects. Structure of the universe.
Course Component: Lecture
Prerequisite: PHY 2361.

PHY 4540 Physique numérique: Méthodes déterministes (3 crédits)
Méthodes numériques déterministes en physique. Solutions numériques des équations de Newton, de Maxwell et de Schrodinger. Dynamique moléculaire. Dynamique non linéaire. Solutions numériques des équations aux dérivées partielles en physique. Éléments finis. Antérieurement PHY 4740.
Volet : Laboratoire, Cours magistral
Préalables : PHY 2733, (PHY 2761 ou CHM 3773), (MAT 2784 ou MAT 2724).

PHY 4541 Physique numérique: Méthodes stochastiques (3 crédits)
Interpolation, régression et modélisation de données. Nombres aléatoires. Techniques de Monte-Carlo. Simulations thermo-statistiques. Percolation, fractales et automates cellulaires. Méthodes numériques stochastiques. Antérieurement PHY 4741.
Volet : Laboratoire, Cours magistral
Préalables : PHY 2733, (MAT 2784 ou MAT 2724), (CHM 3773 ou (PHY 2761, PHY 3750)).

PHY 4711 Introduction à la photonique - lasers (3 crédits)
Introduction à la physique des lasers incluant émission spontanée et stimulée, coefficients d'Einstein, principes de base de l'opération des lasers, interaction lumière-matière linéaire et non-linéaire, dispersion et son contrôle, modes transverses et longitudinaux de cavités résonnantes et régime pulsé à modes bloqués, propagation des faisceaux.
Volet : Cours magistral
Préalables : PHY 2711, PHY 2723. PHY 3770 est concomitant à PHY 4711. Les cours PHY 4711, PHY 4310 ne peuvent être combinés pour l'obtention de crédits.

PHY 4720 Introduction à l'optique quantique (3 crédits)
Théories classique, semi-classique et quantique de l'interaction lumière-matière. Dissipation et décohérence. Fonctions de cohérence classique et quantique, filtres séparateurs et interféromètres; lumière non-classique. Enchevêtrement et information quantique.
Volet : Cours magistral
Préalable: PHY 3770. PHY 3720 est concomitant à PHY 4720.

PHY 4722 Physique biologique (3 crédits)
Application des méthodes de la physique pour l'étude des phénomènes biologiques. Composantes principales d'une cellule. Concepts physiques pertinents aux phénomènes cellulaires: dynamique brownienne, les liquides, suspensions, phénomènes d'origine entropique, forces chimiques et auto-assemblage. Molécules biologiques. Enzymes. Moteurs moléculaires. Impulsions nerveuses.
Volet : Cours magistral
Préalable : PHY 3725 ou concomitant: PHY 3755.

PHY 4724 Technologies énergétiques (3 crédits)
Principes de génération et de transformations énergétiques. Les principales techniques (actuelles et probables) reliées à la production d'énergie électrique, son transport et son stockage, ainsi que les principes économiques associés aux choix de ces technologies. Les thématiques telles les combustibles fossiles, les sources d'énergie renouvelables et les limites thermodynamiques associées à chaque processus seront présentées.
Volet : Cours magistral
Préalables: PHY 2723, PHY 3750.

PHY 4730 Cours avance de dynamique (3 crédits)
Mécanique avancée : formulations de Lagrange et de Hamilton; transformations canoniques; théorie de Hamilton-Jacobi. Relativité : transformations de Lorentz; analyse tensorielle; mécanique classique relativiste.
Volet : Cours magistral
Prerequisites: PHY 2333, PHY 2361.

PHY 4762 Physique subatomique I (3 crédits)
Passage de radiations à travers la matière. Structure nucléaire et systématique. Désintégrations alpha et beta. Interaction entre deux nucléons. Introduction aux particules élémentaires.
Volet : Cours magistral
Préalable : PHY 2761. PHY 3770 est concomitant à PHY 4762.

PHY 4770 Mécanique quantique (3 crédits)
Spin de l'électron. Composition des moments cinétiques. Perturbations dépendantes du temps. Systèmes de particules identiques: bosons et fermions. Théorie de la diffusion.
Volet : Cours magistral
Préalable : PHY 3770.

PHY 4775 Physique atomique, moléculaire et optique (3 crédits)
Introduction aux éléments pertinents de la théorie du moment cinétique, de la théorie des groupes, et aux techniques d'approximation reliées à la physique atomique et moléculaire. Spectres et structure atomique. Discussion détaillée des spectres électroniques, vibratoires et rotationnels. Spectroscopie moléculaire, incluant méthodes à haute résolution. Propriétés électriques et magnétiques des atomes et molécules.
Volet : Cours magistral
Préalable : PHY 3770. Le cours PHY 4770 est concomitant à PHY 4775.

PHY 4782 Introduction à la physique de l'état solide (3 crédits)
Structures des cristaux et leurs déterminations expérimentales. Cohésion des solides. Vibrations des cristaux et propriétés thermiques des solides. Théories de Drude et Sommerfeld des métaux. Bandes d'énergies. Cristaux des semiconducteurs
Volet : Cours magistral
Préalable : PHY 2761. PHY 3750 est concomitant à PHY 4782.

PHY 4785 Physique de l'état solide (3 crédits)
Méthodes de calculs des bandes d'énergie. Phonons. Interaction électron-électron. Couplage électron-phonon. États électroniques dans les défauts. Propriétés optiques des solides. Magnétisme. Théorie de base de la supraconductivité.
Volet : Cours magistral
Préalable : PHY 4782.

PHY 4903 Laboratoire de physique / Physics Laboratory (3 crédits / 3 units)
L'étudiant fera des expériences de nature relativement complexe avec un minimum de direction. Utilisation de micro-ordinateurs pour l'analyse des données expérimentales. Antérieurement PHY 4904. / Experiments of a reasonably complex nature will be carried out by the student with a minimum of detailed supervision. Analysis of experimental data using microcomputers. Previously PHY 4904.
Volet / Course Component: Laboratoire / Laboratory

PHY 4906 Projet de physique / Physics Project (3 crédits / 3 units)
L'étudiant travaillera sur un projet de recherche en physique approuvé, sous la supervision d'un professeur du département. L'étudiant soumettra un rapport écrit et fera une présentation orale. / The student will work on an approved research project in physics under the supervision of a Professor in the Department. A written report and an oral presentation are required.
Volet / Course Component: Recherche / Research
Préalables: 12 crédits de cours en physique (PHY) de niveau 3000 et une MPC minimale de 5.00. Antérieurement PHY 4905. Les cours PHY 4906 et PHY 4006 ne peuvent être combinés pour l'obtention de crédits. Permission du Département. / Prerequisite: 12 course units in physics (PHY) at the 3000 level with a minimum CGPA of 5.00. Previously PHY 4905.The courses PHY 4906 and PHY 4006 cannot be combined for credits. Permission of the Department.

PHY 5100 Solid State Physics I (3 units)
Structures and scattering. Space and reciprocal lattice. One-electron approximation and electron in a periodic potential. Phonons. The Drude and Sommerfeld theory of metals. Band structure calculation. Electron and phonon density of states. Exciton, plasmons, and light matter interaction in crystals. Nanostructures and low-dimensional systems. The course is equivalent to PHYJ 5401 at Carleton University.
Course Component: Lecture

PHY 5110 Solid State Physics II (3 units)
Advanced solid state physics with a focus on properties of interacting systems. Methods of many-body physics, including density functional theory, many-body perturbation theory, configuration interaction, and matrix product states. Quasiparticles. Linear response theory and the random phase approximation. Superconductivity including BCS and Ginzburg-Landau theories. Topics chosen from: Kondo effect; integer and fractional quantum Hall effects; Landau theory of phase transitions; topological phases; the renormalization group; entanglement and quantum information. This course is equivalent of PHYJ 5402 at Carleton University.
Course Component: Lecture

PHY 5112 Physics of Medical Imaging (3 units)
Physical foundation of, and recent developments in, transmission x-ray imaging, computerized tomography, nuclear medicine, magnetic resonance imaging, and ultrasound, for the imaging physics specialist. Imaging system performance: contrast, resolution, modulation transfer function, signal-to-noise ratio, detective quantum efficiency. Essentials of image display and processing. This course is equivalent to PHYS 5204 at Carleton University.
Course Component: Lecture

PHY 5130 Experimental Characterization Techniques in Materials Science, Physics, Chemistry, and Mineralogy (3 units)
Survey of experimental techniques used in materials science, condensed matter physics, solid state chemistry, and mineralogy to characterize materials and solid substances. Diffraction (X-ray diffraction, neutron diffraction...). Spectroscopy (infra-red spectroscopy, Raman spectroscopy, nuclear magnetic resonance, Mössbauer spectroscopy, electron spin resonance...). Microscopy and imaging (scanning electron microscopy, transmission electron microscopy, optical microscopy, magnetic resonance imaging...). Other analytic techniques (thermal analysis, wet chemistry, bulk thermodynamic properties, linear response and dc susceptibility...). This course is equivalent to PHYJ 5001 at Carleton University.
Course Component: Lecture

PHY 5140 Methods in Theoretical Physics I (3 units)
This course is equivalent to PHYS 5801 at Carleton University.
Course Component: Lecture

PHY 5141 Methods in Theoretical Physics II (3 units)
This course is equivalent to PHYS 5802 at Carleton University.
Course Component: Lecture

PHY 5161 Medical Radiation Physics (3 units)
This course is equivalent to PHYS 5203 at Carleton University.
Course Component: Lecture

PHY 5163 Radiation Protection (3 units)
This course is equivalent to PHYS 5208 at Carleton University.
Course Component: Lecture

PHY 5164 Medical Radiotherapy Physics (3 units)
This course is equivalent to PHYS 5206 at Carleton University.
Course Component: Lecture

PHY 5165 Radiobiology (3 units)
This course is equivalent to PHYS 5207 at Carleton University.
Course Component: Lecture

PHY 5166 Medical Physics Practicum (3 units)
This course is equivalent to PHYS 5209 at Carleton University.
Course Component: Lecture

PHY 5167 Advanced Topics in Medical Physics (3 units)
Topics may include medical imaging physics, cancer therapy physics, medical biophysics, or radiation protection and health physics. Topics vary from year to year.
Course Component: Lecture
Prerequisites: PHY 5161 plus, as appropriate to the topic offered, at least one of PHY 5112 , PHY 5164, PHY 5165.

PHY 5168 Anatomy and Physiology for Medical Physicists
Overview of human anatomy and physiology as background for the application of physics to cancer therapy and medical imaging. Anatomy as depicted by imaging technologies such as CT, MRI, and radiography will be emphasized. Graded S (Satisfactory) or NS (Not satisfactory).
Course Component: Lecture
Prerequisite: Enrolment in the graduate field of medical physics.

PHY 5170 Advanced Quantum Mechanics I (3 units)
Review of operators, motion in a general field and angular momentum. Identical particles and exchange, two electron atoms, Hartree-Fock and statistical models of many particle systems. Angular momentum, Clebsch-Gordan coefficients and scattering theory.
Course Component: Lecture

PHY 5304 Introduction to General Relativity (3 units)
Special relativity using tensor analysis. Curved spacetime with physics applications which may include the solar system, stars, black holes, and gravitational waves. Introduction to differential geometry and Einstein's field equations. This course is equivalent to PHYS 5804 at Carleton University.
Course Component: Lecture
Also offered at the undergraduate level, with different requirements, as PHY 4346, for which additional credit is precluded.

PHY 5310 Advanced Optics and Photonics (3 units)
Introduction to laser physics: Optical resonators, light-matter interaction, basic operation of lasers, coherence, light control and manipulation, beam optics, Fourier optics. Guided wave optics: light propagation, allowed modes, dispersion. Courses PHY 5310, PHY 4310 cannot be combined for units. This course is equivalent to PHYJ 5310 at Carleton University.
Course Component: Lecture

PHY 5318 Modern Optics (3 units)
Electromagnetic wave propagation; reflection, refraction; Gaussian beams; guided waves. Laser theory: stimulated emission, cavity optics, 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.
Course Component: Lecture

PHY 5320 Introduction to the Physics of Macromolecules (3 units)
The chemistry of macromolecules and polymers; random walks and the static properties of polymers; experimental methods; the Rouse model and single chain dynamics; polymer melts and viscoelasticity; the Flory-Huggins theory; the reptation theory; computer simulation algorithms; biopolymers and copolymers. This course is equivalent to PHYJ 5508 at Carleton University.
Course Component: Lecture

PHY 5322 Biological Physics (3 units)
Biological phenomena studied using techniques of physics. Key components of cells. Physical concepts relevant to cellular phenomena: Brownian dynamics, fluids, suspensions, entropy driven phenomena, chemical forces and self-assembly. Biological molecules. Enzymes. Molecular motors. Nerve impulses. Also offered, with different requirements, as PHY 4322. Courses PHY 4322, PHY 5322 cannot be combined for units. This course is equivalent to PHYJ 5322 at Carleton University.
Course Component: Lecture
Exclusion: PHY 4322.

PHY 5330 Fiber Optics Communications (3 units)
Optical fibres: description, modes, losses. Optical transmitters: light-emitting diodes and semiconducting lasers. Optical receivers: design, noise, sensitivity, degradation, performance. System design and performance. Optical amplifiers: dispersion management, pre-compensation schemes, post-compensation techniques, dispersion compensating fibres, optical filters, fibre Bragg gratings, soliton generation, long-haul lightwave systems, high-capacity systems. Courses PHY 5330, ELG 5103 cannot be combined for units. This course is equivalent to PHYJ 5330 at Carleton University.
Course Component: Lecture

PHY 5331 Fiber Optics Fundamentals and Applications (3 units)
Fiber optics fundamental, Mach-Zehnder, Michelson, Fabry-Perot, Sagnac based interferometers and phase detections, intensity of wavelength modulated sensors. Principles of Rayleigh, Raman and Brillouin scattering and scattering in fibers, and their applications in distributed sensors. Principles of self-phase and cross phase modulation and four wave mixing in fibers, nonlinear fiber effect based demodulation system for fibers, sensors and device characterization. Birefringence and polarization based sensors and instrumentation.This course is equivalent to PHYJ 5331 at Carleton University.
Course Component: Lecture

PHY 5332 Nonlinear Optics (3 units)
Nonlinear optical susceptibility; wave equation description of nonlinear optics processes: second harmonic generation, intensity dependent refractive index, sum- and frequency-generation, parametric amplification; quantum mechanical theory of nonlinear optics; Brillouin and Raman scattering; the electro-optic effect; nonlinear fibre optics and solitons. This course is equivalent to PHYJ 5332 at Carleton University.
Course Component: Lecture

PHY 5333 Mode Locked Lasers (3 units)
Concept and realization of mode locking. Mode locked lasers including Q-switch. Ultrafast pulse generation and measurement. Soliton generation: dispersion and self-phase modulation. Applications to science and technology. This course is equivalent to PHYJ 5333 at Carleton University.
Course Component: Lecture

PHY 5340 Computational Physics: Deterministic Methods (3 units)
Deterministic numerical methods in physics. Interpolation methods. Numerical solutions of Newton's, Maxwell's and Schrodinger's equations. Molecular dynamics. Non-linear dynamics. Numerical solutions of partial differential equations in physics. Finite elements. This course is equivalent to PHYJ 5004 at Carleton University.
Course Component: Lecture
Courses PHY 5340, PHY 4340 cannot be combined for units.

PHY 5341 Computational Physics: Stochastic Methods (3 units)
Interpolation, regression and modeling. Random number generation. Monte-Carlo methods. Simulations in thermo-statistics. Fractals, percolation, cellular automata. Stochastic numerical methods. This course is equivalent to PHYJ 5005 at Carleton University.
Course Component: Lecture
Courses PHY 5341, PHY 4341 cannot be combined for units.

PHY 5342 Computer Simulations in Physics (3 units)
A course aimed at exploring physics with a computer in situations where analytic methods fail. Numerical solutions of Newton's equations, non-linear dynamics. Molecular dynamics simulations. Monte-Carlo simulations in statistical physics: the Ising model, percolation, crystal growth models. Symbolic computation in classical and quantum physics. This course is equivalent to PHYJ 5003 at Carleton University.
Course Component: Lecture

PHY 5344 Computational Physics (3 units)
Course Component: Lecture

PHY 5347 Physics, Chemistry and Characterization of Mineral Systems (3 units)
The materials science of mineral systems such as the network and layered silicates. In-depth study of the relations between mineralogically relevant variables such as atomic structure, crystal chemistry, site populations, valence state populations, crystallization conditions, etc. Interpretation and basic understanding of key characterization tools such as microprobe analysis, Mössbauer spectroscopy, x-ray diffraction and optical spectroscopy. This course is equivalent to PHYJ 5509 at Carleton University.
Course Component: Lecture

PHY 5355 Statistical Mechanics (3 units)
Ensemble theory. Interacting classical and quantum systems. Phase transitions and critical phenomena. Fluctuations and linear response theory. Kinetic equations. This course is equivalent to PHYJ 5505 at Carleton University.
Course Component: Lecture

PHY 5361 Nonlinear Dynamics in the Natural Sciences (3 units)
A multidisciplinary introduction to nonlinear dynamics with emphasis on the techniques of analysis of the dynamic behaviour of physical systems. Basic mathematical concepts underlying nonlinear dynamics, including differential and difference equations, Fourier series and data analysis, stability analysis, Poincaré maps, local bifurcations, routes to chaos and statistical properties of strange attractors. Applications of these concepts to specific problems in the natural sciences such as condensed matter physics, molecular physics, fluid mechanics, dissipative structures, evolutionary systems, etc. This course is equivalent to PHYJ 5102 at Carleton University.
Course Component: Lecture

PHY 5362 Computational Methods in Material Sciences (3 units)
Introduction to modern computational techniques used in material science research. Classical molecular dynamics, classical and quantum Monte Carlo methods, plane-wave based electronic band structure calculations, Carr-Parrinello quantum molecular dynamics. Applications to condensed matter systems: basic simulation techniques, force-field based methods in the study of thermodynamic and physical properties of solids, first-principles quantum mechanical methods. This course is equivalent to PHYJ 5006 at Carleton University.
Course Component: Lecture

PHY 5363 Physical Applications of Fourier Analysis (3 units)
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, applications to boundary value problems. This course is equivalent to PHYS 5313 at Carleton University.
Course Component: Lecture

PHY 5364 Nanotechnology and Modern methods in Biophysics (3 units)
Modern experimental techniques and nanotechnology used in Biophysics. Topics include biosensors microfluidics, single molecule techniques, DNA sequencing technologies, microfabrication, nanoscale electrokinetics, atomic force microscopy, fluorescence and confocal microscopy, cell chips, etc. Course includes several hands-on experiments. Course open to all graduate students in the faculties of Science and Engineering. This course is equivalent to PHYJ 5364 at Carleton University.
Course Component: Lecture

PHY 5380 Semiconductor Physics I (3 units)
Brillouin zones and band theory. E-k diagram, effective mass tensors, etc. Electrical properties of semiconductors. This course is equivalent to PHYJ 5407 at Carleton University.
Course Component: Lecture

PHY 5381 Semiconductor Physics II: Optical Properties (3 units)
Optical constants and dispersion theory. Optical absorption, reflection, and band structure. Absorption at band edge and excitons. Lattice, defect and free-carrier absorption. Magneto-optics. Photo-electronic properties, luminescence, detector theory. Experimental methods.
Course Component: Lecture

PHY 5384 Physics of Fiber Optic Systems (3 units)
Physics of electromagnetic waves in fiber-optic systems. Laser madulation, chirp effects, noise. Amplitude, frequency and phase modulation. Optical dispersion (chromatic dispersion, polarization mode dispersion and polarization-dependent losses). Fiber losses and non-linear effects. Optical detectors, receivers, signal to noise ratio, power penalties. Overall system design. This course is equivalent to PHYJ 5308 at Carleton University.
Course Component: Lecture

PHY 5387 Physics of Materials (3 units)
Microscopic characteristics related to the physical properties of materials. Materials families: metals and alloys, ceramics, polymers and plastics, composites, layered materials, ionic solids, molecular solids, etc. Specific materials groups. Equilibrium phase diagrams and their relation to microstructure and kinetics. Experimental methods of characterization. Interactions and reactions. This course is equivalent to PHYJ 5504 at Carleton University.
Course Component: Lecture

PHY 5388 Photons and Atoms (3 units)
Atomic and Molecular structure and transitions, semi-classical light-matter interaction; two level systems time-dependent perturbation theory and Ferni's golden rule; optical Bloch equations; coherent control; optical interactions with three-level systems, electromagnetically induced transparency; optical forces; laser cooling; Bose-Einstein condensation; atoms optics and interferometers; basic quantization og light. This course is equivalent to PHYJ 5388 at Carleton University.
Course Component: Lecture

PHY 5389 Quantum Theory of Light (3 units)
Quantum cryptography; entanglement; density operators; Bell's inequalities; quantization of the light field; Lam shift; Casimir effect; the vacuum; quantum optical states; Photon and homodyne detectors; quasi-probability functions; beam-splitters and other optical transformations; classical and quantum coherence; Hanbury Brown and Twiss effect, Hong-Ou-Mandel interference; quantum nonnlinear optics; quantum light-matter interactions; open quantum systems. This course is equivalent to PHYJ 5389 at Carleton University.
Course Component: Lecture

PHY 5390 Quantum Science and Technology (3 units)
Interdisciplinary nature of the rapidly advancing field of quantum science and technology. The wide-range of topics include: foundations of quantum mechanics and quantum information, quantum materials, quantum communication, quantum sensing and metrology, quantum computing and simulations. This course is equivalent to PHYJ 5390 at Carleton University.
Course Component: Lecture

PHY 5391 Quantum Materials, Nanostructures and Devices (3 units)
Electronic and optical properties of semiconductor nanostructures (quantum wells, wires and dots), topological insulators, and 2D crystals: single particle properties, many-electron description, response functions and computational tools. Applications to single electron transistors, lasers, solar cells, and Majorana quantum circuits. This course is equivalent to PHYJ 5391 at Carleton University.
Course Component: Lecture

PHY 5392 Introduction to Nanoscience (3 units)
Nanoscience with photons (ray and wave optics), nanoscience with charged particles (light matter interaction, SEM, TEM), nanoscience with physical probes. This course is equivalent to PHYJ 5392 at Carleton University.
Course Component: Lecture

PHY 5722 Physique biologique (3 crédits)
Application des méthodes de la physique à l'étude des phénomènes biologiques. Composantes principales d'une cellule. Concepts physiques pertinents aux phénomènes cellulaires : dynamique brownienne, liquides, suspensions, phénomènes d'origine entropique, forces chimiques et auto-assemblage. Molécules biologiques. Enzymes. Moteurs moléculaires. Impulsions nerveuses. Offert également, avec des exigences différentes, sous la cote PHY 4722. Les cours PHY 4722, PHY 5722 ne peuvent être combinés pour l'obtention de crédits. Ce cours est équivalent à PHYJ 5722 à la Carleton University.
Volet : Cours magistral
Exclusion: PHY 4322.

PHY 5740 Physique numérique: Méthodes déterministes (3 crédits)
Méthodes numériques déterministes en physique. Techniques d'interpolation. Solutions numériques des équations de Newton, de Maxwell et de Schrödinger. Dynamique moléculaire. Dynamique non-linéaire. Solutions numériques des équations aux dérivées partielles en physique. Éléments finis. Ce cours est équivalent à PHYJ 5502 à la Carleton University.
Volet : Cours magistral
Les cours PHY 5740, PHY 4740 ne peuvent être combinés pour l'obtention de crédits.

PHY 5741 Physique numérique: Méthodes stochastiques (3 crédits)
Interpolations, régression et modélisation de données. Nombres aléatoires. Techniques de Monte-Carlo. Simulations thermo-statistiques. Percolation, fractales et automates cellulaires. Méthodes numériques stochastiques. Ce cours est équivalent à PHYJ 5503 à la Carleton University.
Volet : Cours magistral
Les cours PHY 5741, PHY 4741 ne peuvent être combinés pour l'obtention de crédits.

PHY 5742 Simulations numériques en physique (3 crédits)
Un cours ayant pour but d'étudier la physique à l'aide d'un ordinateur dans des situations où les méthodes analytiques sont inadéquates. Solutions numériques des équations de Newton. Dynamique non-linéaire. Simulations de dynamique moléculaire. Simulations Monte-Carlo en physique statistique : modèle d'Ising, percolation, croissance cristalline. Calcul symbolique en physique classique et quantique. Les cours PHY 5742, PHY 5344 ne peuvent être combinés pour l'obtention de crédits. Ce cours est équivalent à PHYJ 5506 à la Carleton University.
Volet : Cours magistral

PHY 5781 Physique des semi-conducteurs II : Propriétés optiques (3 crédits)
Constantes optiques et théorie de la dispersion. Absorption optique, réflexion et structure de bandes. Seuil d'absorption et excitons. Absorption due au réseau, aux défauts et aux porteurs libres. Magnéto-optique. Propriétés photo-électroniques, luminescence, théorie des détecteurs. Méthodes expérimentales.
Volet : Cours magistral

PHY 5804 Introduction to General Relativity (3 crédits)
Special relativity using tensor analysis. Curved spacetime with physics applications which may include the solar system, stars, black holes, and gravitational waves. Introduction to differential geometry and Einstein's field equations.
Volet : Cours magistral
Also offered as PHY 4346 at the undergraduate level with different requirements for which additional credit is precluded.

PHY 5922 Advanced Magnetism (3 crédits / 3 units)
Study of some of the experimental and theoretical aspects of magnetic phenomena found in ferro-, ferri-, antiferro-magnetic and spin glass materials. Topics of current interest in magnetism. This course is equivalent to PHYJ 5507 at Carleton University.
Volet / Course Component: Cours magistral / Lecture

PHY 5951 Physique de basses températures / Low Temperature Physics II (3 crédits / 3 units)
Properties of matter at low temperatures. Helium Physics. Thermometry at Low Temperatures. Theory and Technology of Cryogenics Refrigerators. Applied Superconductivity. Recent developments: Cryoelectronic, Quantum Hall Effect. Helium Crystal Growth, Nuclear Magnetic Ordering, Cryogenic Detectors and Polarised Target for High Energy Physics. This course is equivalent to PHYJ 5409 at Carleton University. / Properties of matter at low temperatures. Helium Physics. Thermometry at Low Temperatures. Theory and Technology of Cryogenics Refrigerators. Applied Superconductivity. Recent developments: Cryoelectronic, Quantum Hall Effect. Helium Crystal Growth, Nuclear Magnetic Ordering, Cryogenic Detectors and Polarised Target for High Energy Physics. This course is equivalent to PHYJ 5409 at Carleton University.
Volet / Course Component: Cours magistral / Lecture

PHY 5966 Physique nucléaire / Experimental Techniques of Nuclear and Elementary Particle Physics (3 crédits / 3 units)
Ce cours est équivalent à PHYS 5601 à Carleton University. / The interaction of radiation and high energy particles with matter; experimental methods of detection and acceleration of particles; use of relativistic kinematics; counting statistics. This course is equivalent to PHYS 5601 at Carleton University.
Volet / Course Component: Cours magistral / Lecture

PHY 5967 Physique des particules / Elementary Particle Physics (3 crédits / 3 units)
Ce cours est équivalent à PHYS 5602 à la Carleton University. / This course is equivalent to PHYS 5602 at Carleton University.
Volet / Course Component: Cours magistral / Lecture

PHY 6170 Advanced Quantum Mechanics II (3 units)
Systems of identical particles and many-body theory. Lattice and impurity scattering. Quantum processes in a magnetic field. Radiative and non-radiative transitions. Introduction to relativisitic quantum mechanics. This course is equivalent to PHYJ 5703 at Carleton University.
Course Component: Lecture

PHY 6371 Topics in Mossbauer Spectroscopy (3 units)
Experimental techniques used to measure Mössbauer spectra. Physics of the Mössbauer effect: recoilless emission/absorption, anisotropic Debye-Waller factors, second order Doppler shifts, etc. Mössbauer lineshape theory with static and dynamic hyperfine interactions. Distributions of static hyperfine parameters. Physics of the hyperfine parameters: origin of the hyperfine field, transferred and supertransferred fields, calculations of electric field gradients, etc. Applications of Mössbauer spectroscopy to various areas of solid state physics and materials science. This course is equivalent to PHYJ 5404 at Carleton University.
Course Component: Lecture

PHY 6382 Physics of Semiconductor Super Lattices (3 units)
Fundamental physics of two-dimensional quantized semiconductor structures. Electronic and optical properties of superlattices and quantum wells. Optical and electronic applications. This course is intented for students registered for the Ph.D. in semconductor physics research. This course is equivalent to PHYJ 6406 at Carleton University.
Course Component: Lecture
Prerequisite: Advanced undergraduate or graduate course in solid state physics.

PHY 6650 Supraconductivité II (2 crédits)
Volet : Cours magistral

PHY 6782 Physique des super-réseaux à semiconducteurs (3 crédits)
Physique fondamentale des structures quantiques bi-dimensionnelles à semiconducteurs. Propriétés électroniques et optiques des super-réseaux et puits quantiques. Applications à l'électronique et à l'optique. Ce cours est destiné aux étudiantes et aux étudiants inscrits au doctorat en physique des semiconducteurs. Ce cours est équivalent à PHYJ 6407 à la Carleton University.
Volet : Cours magistral
Préalable : Cours sénior ou de niveau supérieur en physique de l'état solide.

PHY 6999 Project (6 crédits / 6 units)
Projet en physique dirigé par un professeur approuvé par le directeur des études supérieures et donnant lieu à la rédaction d'un rapport approfondi (30-40 pages approx). Noté S (satisfaisant) ou NS (non satisfaisant) par le directeur du projet et un autre professeur nommé par le directeur des études supérieures en physique. Le projet est normalement complété en une session. / Project in physics supervised by a professor approved by the director of graduate studies and leading to the writing of an in-depth report (approx. 30-40 pages). Graded S (Satisfactory) or NS (Not satisfactory) by the supervisor and by another professor appointed by the director of graduate studies in Physics. The project will normally be completed in one session. Volet / Course Component: Recherche / Research
Volet / Course Component: Recherche / Research

PHY 8111 Classical Mechanics and Theory of Field (3 units)
This course is equivalent to PHYS 5101 at Carleton University.
Course Component: Lecture

PHY 8122 Molecular Spectroscopy (3 units)
This course is equivalent to PHYS 5202 at Carleton University.
Course Component: Lecture

PHY 8132 Classical Electrodynamics (3 units)
Covariant formulation of electrodynamics; Lenard-Wiechert potentials; radiation reaction; plasma physics; dispersion relations. This course is equivalent to PHYS 5302 at Carleton University.
Course Component: Lecture

PHY 8164 Intermediate Nuclear Physics (3 units)
This course is equivalent to PHYS 5604 at Carleton University.
Course Component: Lecture

PHY 8165 Particle Physics Phenomenology (3 units)
This course is equivalent to PHYS 6601 at Carleton University.
Course Component: Lecture

PHY 8166 Advanced Topics in Particle Physics Phenomenology (3 units)
This course is equivalent to PHYS 6602 at Carleton University.
Course Component: Lecture

PHY 8172 Relativistic Quantum Mechanics (3 units)
This course is equivalent to PHYS 5702 at Carleton University.
Course Component: Lecture

PHY 8173 Quantum Electrodynamics (3 units)
This course is equivalent to PHYS 6701 at Carleton University.
Course Component: Lecture

PHY 8191 Selected Topics in Physics (3 units)
This course is equivalent to PHYS 5901 at Carleton University.
Course Component: Lecture

PHY 8192 Selected Topics in Physics (1.5 unit)
Topics of current interest in Physics. Variable content year to year.
Course Component: Lecture

PHY 8260 Advanced Nuclear Physics (6 units)
Course Component: Lecture

PHY 8290 Selected Topics in Physics (MSc) (6 units)
This course is equivalent to PHYS 5900 at Carleton University.
Course Component: Lecture

PHY 8391 Selected Topics in Physics (PhD) (3 units)
This course is equivalent to PHYS 6901 at Carleton University.
Course Component: Lecture

PHY 8490 Selected Topics in Physics (PhD) (6 units)
This course is equivalent to PHYS 6900 at Carleton University.
Course Component: Lecture

PHY 9998 Examen de synthèse (Doctorat) / Comprehensive Examination (PhD)
Volet / Course Component: Recherche / Research