MASTER OF SCIENCE PHYSICS

Overview

Summary

- Degree offered: Master of Science (MSc)
- Registration status options: Full-time; Part-time
- Language of instruction: English

  Most of the requirements of this program must be fulfilled in English. Research activities may be conducted in English or in French, or in both languages, depending on the main language of the professor and of the members of the research group.

- Program options (expected duration of the program):
  - with thesis, standard stream (6 full-time terms; 24 consecutive months)
  - with thesis, accelerated stream (3 full-time terms; 12 consecutive months)
  - with courses only (4 full-time terms, 16 consecutive months)
  - with courses and Co-op option (4 full-time terms; 16 consecutive months)
  - with courses and Project (4 full-time terms, 16 consecutive months)

    For immigration purposes, the summer term (May to August) for this program is considered a regularly scheduled break approved by the University. Students should resume full-time studies in September.

- Academic units: Faculty of Science (https://science.uottawa.ca/en/), Department of Physics (https://science.uottawa.ca/physics/), Ottawa-Carleton Institute for Physics (http://ocip.ca/).

Program Description

Ottawa-Carleton Institute for Physics

Established in 1983, the Ottawa-Carleton Institute for Physics (OCIP) combines the research strengths of the University of Ottawa and Carleton University. The Institute offers graduate programs leading to the master's (MSc) and doctoral (PhD) degrees in Physics.

Research facilities are shared between the two campuses. Students have access to the professors, courses and facilities at both universities; however, they must enroll at the "home university" of the thesis supervisor.

Main Areas of Research

- Condensed matter
- High energy physics
- Biological physics
- Medical physics
- Photonics

Other Programs Offered Within the Same Discipline or in a Related Area

- Master of Science Physics Specialization in Science, Society and Policy (MSc)
- Master of Science Physics Concentration in Quantum Science (MSc)
- Doctorate in Philosophy Physics (PhD)

Fees and Funding

- Program fees:

The estimated amount for university fees (https://www.uottawa.ca/university-fees/) associated with this program are available under the section Finance your studies (http://www.uottawa.ca/graduate-studies/programs-admission/finance-studies/).

International students enrolled in a French-language program of study may be eligible for a differential tuition fee exemption (https://www.uottawa.ca/university-fees/differential-tuition-fee-exemption/).

- To learn about possibilities for financing your graduate studies, consult the Awards and financial support (https://www.uottawa.ca/graduate-studies/students/awards/) section.

Notes

- Programs are governed by the academic regulations (http://www.uottawa.ca/graduate-studies/students/general-regulations/) in effect for graduate studies.
- In accordance with the University of Ottawa regulation, students have the right to complete their assignments, examinations, research papers, and theses in French or in English.

Program Contact Information

Graduate Studies Office, Faculty of Science (https://science.uottawa.ca/en/faculty-services/graduate-studies/)
30 Marie-Curie Street, Gendron Hall, Room 181
Ottawa ON Canada
K1N 6N5

Tel.: 613-562-5800 x3145
Email: gradsci@uottawa.ca (engineering.grad@uottawa.ca)

Twitter | Faculty of Science (https://twitter.com/uOttawaScience/?lang=en)
Facebook | Faculty of Science (https://www.facebook.com/uOttawaScience/)

Admission Requirements

For the most accurate and up to date information on application deadlines, language tests and other admission requirements, please visit the specific requirements (https://www.uottawa.ca/graduate-studies/programs-admission/apply/specific-requirements/) webpage.

To be eligible for the standard stream of the MSc, candidates must:

- Be the holder of a bachelor's degree with a specialization, or a major in physics (or equivalent) with a minimum average of 70% (B).

  Note: International candidates must check the admission equivalencies (https://www.uottawa.ca/graduate-studies/

international/study-uottawa/admission-equivalencies/) for the diploma they received in their country of origin.

- Demonstrate a good academic performance as shown by official transcripts, research reports, abstracts or any other documents demonstrating research skills.
- Meet the funding requirements.

  Note: International students must provide proof of financial support: i.e., a stipend provided by a supervisor as well as a combination of awards and/or trust funds.

- Identify at least one professor who is willing to supervise your research and thesis.
  - We recommend that you contact potential thesis supervisors as soon as possible.
  - To register, you need to have been accepted by a thesis supervisor.
  - The supervisor's name is required at the time of application.

To be eligible for the accelerated stream of the MSc, candidates must:

- Have to be an undergraduate student admitted to the University of Ottawa
- Have been enrolled in PHY 4006 (or equivalent) the year prior to the entry in the MSc.
- Have an admission average of 8.0.

  Note: International candidates must check the admission equivalencies (https://www.uottawa.ca/graduate-studies/international/study-uottawa/admission-equivalencies/) for the diploma they received in their country of origin.

- Have completed, with a grade of at least A-, a 4000- or 5000-level course in physics (PHY) that can be counted towards the MSc.
- Have a thesis supervisor who has agreed to continue directing the candidate's research at the MSc level.

  Note: The choice of supervisor will determine the student's primary campus location. It will also determine which university awards the degree.

Language Requirements

Applicants must have a good knowledge of either English or French and a good ability to write in English.

Applicants whose first language is neither French nor English must provide proof of proficiency in the language of instruction.

Note: Candidates are responsible for any fees associated with the language tests.

Notes

- The admission requirements listed above are minimum requirements and do not guarantee admission to the program.
- Admissions are governed by the academic regulations (http://www.uottawa.ca/graduate-studies/students/general-regulations/) in effect for graduate studies.

Applying to the Co-op Option

In order to apply to the co-op option, you must first be admitted to a program that offers co-op.

Your application must be submitted by the end of the first month of enrollment in your primary program, i.e., by the end of September.

Admission to the co-op option occurs on a competitive basis and is managed by the Co-op Office (https://coop.uottawa.ca/en/). Inquiries should be directed to that office.

- To be admitted to the co-op option, you must:
  - be enrolled as a full-time student in the Master of Science Physics, Applied Physics Option;
  - have and maintain a minimum CGPA of B+ (75%);
  - begin the program in the Fall term;
  - be a Canadian citizen or permanent resident;
  - pay the required co-op fees.
- International students who have not been exempted of this condition must:
  - have passed the CanTest with a score of 4.0.

Program Requirements Master's with Thesis

Students must meet the following requirements:

Participation in the Institute's seminar series is compulsory.

Compulsory Courses:		
9 optional course units in physics (PHY) at the graduate level [1, 2]		9 Units
Thesis:		
THM 7999	Master's Thesis [3]	

Note(s)

1

The optional course units may be selected in related disciplines approved by the Department of Physics.

2

For students accepted into the accelerated stream, the number of courses to be completed while enrolled in the MSc is reduced to two.

3

Students are responsible for ensuring they have met all of the thesis requirements (http://www.uottawa.ca/graduate-studies/students/theses/).

Master's with Physics - Applied Physics Option

Requirements for this program have been modified. Please consult the 2018-2019 calendars (http://catalogue.uottawa.ca/en/archives/) for the previous requirements.

Students must meet the following requirements:

Participation in the Institute's seminar series is compulsory.

Course option		
24 optional course units in physics (PHY) at the graduate level [1]		24 Units

Project option		
18 optional course units in physics (PHY) at the graduate level [1]		18 Units
PHY 6999	Project	6 Units
Total:		**24 Units**

1

The optional course units may be selected in related disciplines approved by the Department of Physics such as Engineering, Mathematics, Computer Science and Chemistry.

Co-op Option

(Available to students enrolled in the the coursework option.)

Co-op students must enroll full-time and successfully complete one work term (SCI 6001).

Each work terms is graded P/F (pass/fail), based on the employer's report and on the written report completed by the student.

To remain enrolled in the Co-op option, a student must:

- maintain full-time status up to and including the term following the work term,
- maintain a cumulative grade point average of B+ in their program, and
- obtain a satisfactory grade (P) for the Co-op work term.

Fast-Track from Master's to PhD

Students enrolled in the master's program in Physics at the University of Ottawa may be eligible to fast-track directly into the doctoral program without writing a master's thesis. For additional information, please consult the "Admission Requirements" section of the PhD program.

Minimum Requirements

The passing grade in all courses is B. Students who fail two courses, or the thesis proposal, or whose research progress is deemed unsatisfactory must withdraw from the program.

Research

Research at the University of Ottawa

Located in the heart of Canada's capital, a few steps away from Parliament Hill, the University of Ottawa ranks among Canada's top 10 research universities. Our research is founded on excellence, relevance and impact and is conducted in a spirit of equity, diversity and inclusion.

Our research community thrives in four strategic areas:

- Creating a sustainable environment
- Advancing just societies
- Shaping the digital world
- Enabling lifelong health and wellness

From advancing healthcare solutions to tackling global challenges like climate change, the University of Ottawa's researchers are at the forefront of innovation, making significant contributions to society and beyond.

Research at the Faculty of Science

The Faculty of Science has become a true centre of excellence in research through its world-class professors as well as its programs and infrastructure in Biology, Chemistry, Earth Sciences, Mathematics and Statistics, and Physics.

The research accomplished by its 140 internationally recognized professors, its approximately 400 graduate students and its dozens of postdoctoral researchers and visiting scientists has positioned the Faculty of Science as one of the most research intensive science faculties in Canada. Our professors have received many international and national awards including three NSERC Gerhard Herzberg Gold Medal winners and numerous Fellows of the Royal Society of Canada.

The Faculty of Science, through its strategic use of infrastructure programs, hosts world-class Core Facilities and is at the leading edge for the study of Catalysis, Experimental and Computational Chemistry, Environmental Toxins, Nuclear Magnetic Resonance, Isotope Analysis, Molecular Biology and Genomics, X-Ray Spectrometry/Diffractometry, Geochemistry, Mass Spectrometry, Physiology and Genetics of Aquatic Organisms, and Photonics. The Faculty is also associated with the Fields Institute for research in mathematical science and the Centre de recherche mathématiques (CRM) at the Université de Montréal, providing a unique setting for mathematical research.

For more information, refer to the list of faculty members and their research fields on **Uniweb**.

IMPORTANT: Candidates and students looking for professors to supervise their thesis or research project can also consult the website of the faculty or department **(**https://www.uottawa.ca/study/graduate-studies/academic-unit-contact-information/**) of their program of choice. Uniweb does not list all professors authorized to supervise research projects at the University of Ottawa.**

Courses

Not all of the listed courses are given each year. The course is offered in the language in which it is described.
Course codes in parentheses are for Carleton University. A 3-unit course at the University of Ottawa is equivalent to a 0.5-unit course at Carleton University.

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 nonlinear 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