

**DEPARTMENT OF PHYSICS
BROCK UNIVERSITY**

**GRADUATE (M.Sc. and Ph.D.) PROGRAM HANDBOOK
ACADEMIC YEAR 2012-13**

<http://www.physics.brocku.ca/Programs/Graduate/>

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1. Program description

The Brock Department of Physics offers thesis-based Master of Science and Doctor of Philosophy programs which focus on condensed matter physics, materials science, theoretical physics, and biophysics. Potential fields of research which may be pursued are described below.

1.1. Fields of specialization

Experimental Condensed Matter Physics and Materials Science:

Investigation of the optical properties of materials with phase transitions (*e.g.*, ferromagnets, superconductors, heavy fermion, spin- and charge-density wave compounds) via optical spectroscopy from mm wave to uv. Preparation and characterization of ceramic, single crystal and thin film (using pulsed-laser deposition) high- T_c superconductors, CMR materials (manganites) and amorphous alloys. Magnetic and transport properties at ambient and high pressure utilizing measurement techniques such as SQUID magnetometry, specific heat, and dc-resistivity.

Theoretical physics:

Superconductivity: unconventional pairing, novel materials (high- T_c , magnetic, *etc.*), localization and superconductivity, superconducting glassy state. Transport in metals: transport properties of heavy fermion systems. Non-crystalline materials: calculation of electronic structure and transport properties of amorphous and liquid metals, quasicrystals, alloys and semiconductors, vibrational and magnetic properties of amorphous solids. Linear response calculations of electron-phonon interaction and superconductivity in solids. Quantum Monte Carlo studies of physical properties of isolated atoms and molecules. Monte Carlo and molecular dynamics studies of biological molecules. Dynamic systems. Mathematical physics.

Biophysics:

Nuclear Magnetic Resonance spectroscopy and relaxation measurements in soft condensed matter systems. Study of collective motions in model membranes, phase transitions in liquid crystals. Exploration of various morphologies and phase behaviour of lipid/water systems using scattering techniques (*e.g.* neutrons, x-ray and light). Study of the protein/membrane interactions; structural characteristics of membrane active peptides. Biophysics of photosynthetic energy conversion using a combination of specialized optical spectroscopic techniques and theoretical models for excitation energy transfer and electron transport. Time-resolved Electron Spin Resonance spectroscopy and light-induced spin polarization in

photosynthetic membrane proteins and donor acceptor molecular complexes. Investigation of energy and electron transfer and spin dynamics in these systems.

1.2. Graduate faculty

Every student in the program is supervised by a member of the Physics graduate faculty. Joint supervisions by two or more faculty members are possible. Adjunct faculty may co-supervise graduate students with faculty from the Department of Physics.

Professors

Stephen Anco (Mathematics), Shyamal K. Bose (Physics), Douglas H. Bruce (Biological Sciences), Bozidar Mitrovic (Physics), Fereidoon S. Razavi (Physics), Maureen Reedyk (Physics), Stuart M. Rothstein (Chemistry), Kirill Samokhin (Physics), Art van der Est (Chemistry), Jan Vrbik (Mathematics), Thomas Wolf (Mathematics)

Associate Professors

David A. Crandles (Physics), Henryk Fuks (Mathematics), Thad A. Harroun (Physics), Alexander Odesskii (Mathematics), Edward Sternin (Physics)

Adjunct Professors

James A. Blackburn (Wilfrid Laurier University), John Katsaras (NRC, Chalk River), Reinhard Kremer (Max-Planck Institute, Germany), Gerald Moran (McMaster University), Ole Steuernagel (University of Hertfordshire, UK)

Professors Emeritus

Ramesh C. Shukla (Physics)

Graduate Program Director

Prof. Kirill Samokhin, Kirill.Samokhin@brocku.ca

Graduate Officer of the Faculty of Mathematics and Science

Beulah Alexander, balexander@brocku.ca
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Administrative Assistant

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2. Admission requirements

Detailed information about the admission procedure and the University admission requirements can be found on the Faculty of Graduate Studies webpage, currently at

https://experience.brocku.ca/Graduate_Study/applynow.ezc

MSc

Candidates for the program require successful completion of an Honours Bachelor's degree, or equivalent, in Physics, with a minimum 75% overall grade average from an accredited institution. Students whose grade averages are between 70% and 75% can be admitted into the program in exceptional circumstances. Applicants holding a degree without sufficient concentration in the area of the intended Master's degree, may be required to complete additional courses beyond those outlined as required for degree completion. The Graduate Record Examination (GRE) is recommended for international students but not required. Agreement from a member of the Physics graduate faculty to supervise the student is also required for admission to the program.

The Physics Graduate Admissions Committee will review all applications and recommend admission for a limited number of suitable candidates.

Students are normally admitted as full-time students. Part-time candidates may be considered.

PhD

Students can be admitted into the PhD program through one of the following three options:

1. After successful completion of a MSc degree (or equivalent) in Physics or a closely related discipline, with at least an 80% overall average.
2. After one year in the Brock Physics MSc program. Students wishing to transfer to the PhD stream will be expected to have completed all required Master's coursework, with at least an 80% average. Requests to transfer must be approved by the student's supervisory committee (normally, at the second biannual meeting in the first year of the student's MSc program) and then submitted to the Graduate Program Director, at least four weeks prior to the transfer date. The Request to Transfer Form is available at the Physics graduate program website, see also Appendix C.

- 3.** In exceptional cases, a student may be admitted directly to the PhD program with a four-year honours Bachelors' degree, or the equivalent; his or her academic standing (normally, with at least an 85% major average) and research potential must be demonstrably commensurate with readiness for doctoral study.

If a student admitted through option 1 or 2 did not complete graduate courses in Advanced Quantum Mechanics, Advanced Statistical Physics, and Advanced Electrodynamics prior to their admission to the PhD program, they will be required to complete them as part of the PhD degree requirements.

Students admitted into the PhD program cannot transfer into the MSc stream.

The Graduate Record Examination (GRE) is recommended for international students, but not required. Agreement from a member of the Physics graduate faculty to supervise the student is also required for admission to the program.

The Graduate Admissions Committee will review all applications and recommend admission for a limited number of suitable candidates.

Only full-time PhD students will be admitted.

3. Degree requirements

MSc

For full-time students, the program duration is normally 6 terms (two years). The minimum residency requirement is 3 terms of full-time registration. Full-time students must complete all course and thesis requirements within three years from the date of first registration. Any extension beyond the normal two-year period must be approved by the supervisory committee and the Graduate Program Director. For part-time students, the maximum program duration is five years.

All students must complete a research project that culminates in writing and defending a thesis. There will be an oral defence of the thesis.

Students must enroll in PHYS 5F90 (MSc Thesis) each term. In addition to PHYS 5F90, students must complete a minimum of four PHYS half-credits of coursework. Only one half-credit may be at the 4(alpha)00 level, and credits obtained in the graduate seminar courses (PHYS 5P91/7P91) cannot be counted as part of the course requirements. Depending on their background and progress in the program, students may be required by the supervisory committee to take additional credits. Detailed information about the registration policies and procedures can be found on the Graduate Studies webpage, currently at <http://www.brocku.ca/graduate-studies/current-students>

PhD

For students entering the PhD program through option 1 or 3, the program duration is normally 12 terms (four years). For students entering the PhD program through option 2, the program duration is normally 15 terms (five years) inclusive of the time spent in the MSc. The minimum residency requirement is 6 terms for options 1 and 2, and 9 terms for option 3. Students must complete all degree requirements within six years from the date of first registration.

All students must complete a research project that culminates in writing and defending a thesis. There will be an oral defence of the thesis. Students must enroll in PHYS 7F90 (PhD Thesis) each term.

Students admitted through option 1 or 2 must obtain a minimum of two PHYS graduate half-credits, pass two graduate seminar courses (PHYS 5P91 and PHYS 7P91), and pass the scientific writing course (PHYS 5N01).

Students admitted through option 3 must obtain a minimum of four PHYS graduate half-credits (which must include Advanced Quantum Mechanics, Advanced Statistical Physics, and Advanced Electrodynamics), pass the two graduate seminar courses, and pass the scientific writing course.

Advanced Quantum Mechanics, Advanced Statistical Physics, and Advanced Electrodynamics are core graduate Physics courses. Every PhD student must have credits in all three core courses.

Students must also successfully complete a comprehensive exam, which takes place within the first 24 months of their PhD program. Students must complete all their course requirements (except the thesis, the graduate seminars, and the writing course) before the comprehensive exam.

3.1. Courses

The list of graduate PHYS courses currently offered by the Brock Department of Physics is given in Appendix A. Please note that not all courses are offered in every academic year. Refer to the timetable for scheduling information, currently at <http://www.brocku.ca/registrar/guides/grad/timetable/terms.php>

Students choose their courses in consultation with their thesis supervisor and the supervisory committee and must have their course selections approved by both the supervisor and the Graduate Program Director each term. Depending on their background and progress in the program, students may be required to take additional credits, either by the supervisory committee or at the time of admission.

The thesis supervisor may not offer all the courses in a student's program. When appropriate and with prior permission of the supervisory committee and an approval of the Graduate Program Director, courses offered outside the Department of Physics (*i.e.* those not listed or cross-listed as PHYS) may be taken to fulfil course requirements.

Graduate credit is not given in courses where the final grade is less than 70%. Obtaining a failing grade (<70%) in a graduate course is sufficient grounds for dismissal from the program. While a failed course may be repeated, no course may be repeated more than once, and no more than a total of one credit may be repeated.

3.2. Teaching assistantship

In addition to the coursework, students will participate in the running of undergraduate courses in the Brock Department of Physics as teaching

assistants (for which a graduate teaching assistantship stipend will be paid), for a minimum of three terms. The responsibilities will include grading undergraduate student work and/or serving as a laboratory demonstrator or tutorial leader.

The maximum total number of TA hours currently permitted by the Faculty of Graduate Studies is 240 hours/year, or 120 hours/term.

4. Financial matters

For the defined normal duration of the graduate Physics program at Brock, full-time students will normally be supported by some combination of a research assistantship paid from the research grants of supervising faculty, a graduate fellowship from the University, teaching assistantship stipends from the Department of Physics, and possibly some provincial or federal scholarships. In addition, international students may receive bursaries to help offset the cost of higher tuition fees. Students of good academic standing and in financial need may qualify for additional scholarships or bursaries. Students should make sure that they understand exactly how they will be supported and for how long.

Information about internal and external financial support available to students can be found on the Faculty of Graduate Studies website, currently at <http://www.brocku.ca/graduate-studies/current-students/internal-financial-support> and <http://www.brocku.ca/graduate-studies/current-students/financial-information>

Supervisors are not obligated to provide any form of research assistantship beyond the normal funding period for a full-time graduate student. Please also note that the current rules of the Teaching Assistants' Union give preference to graduate students only during the first two years of their program.

Students receiving support from the supervisor's research grants are expected to provide a reasonable work return on duties assigned to them by the supervisor.

In addition to the tuition fee, students are required to pay other fees, such as Health Services Fee, Athletics Fee, University Health Insurance Fee (for foreign students), *etc.* For more information about the fees, the financial support available, and the cost of living in St. Catharines, please consult the Graduate Studies webpage, currently at <http://www.brocku.ca/graduate-studies/current-students/tuition-and-fees>

4.1. Termination of funding

Financial support from the program may be reduced or terminated only for cause. This may be done only on the recommendation of the supervisory committee and approved by the Graduate Program Director. Such reasons may include, but are not restricted to the following:

- failure to carry on research at a rate deemed reasonable by the supervisory committee;
- failure to perform teaching assistantship duties adequately;
- proven instances of academic misconduct in research and/or coursework.

5. Graduate supervisory committees

All graduate students are supervised by a supervisory committee. The supervisory committee usually consists of the student's research supervisor (or supervisors, in the case of a joint supervision) and two additional faculty members from the Physics graduate program, one of whom will serve as Chair of the committee. Exceptions to this structure may occur, *e.g.*, when the supervisor's primary appointment is not in Physics.

Supervisory committees are formed by the Graduate Program Director, who will ensure that at least one other committee member will be from the same research area as the student and the supervisor. Normally, at least two of the research areas of the Department of Physics will be represented on the committee. The Graduate Program Director will attempt to distribute supervisory committee duties equitably among faculty.

In the absence of the supervisor (*e.g.*, during a sabbatical), the Graduate Program Director, in consultation with the supervisory committee, shall ensure that a resident faculty member is responsible for overseeing the student. In the event that the supervisor leaves the University permanently, the Graduate Program Director, in consultation with the supervisory committee, shall appoint a new supervisor.

If either the student or supervisor wishes to initiate a change in supervisor, the request must be presented in writing, with explanation, to the Graduate Program Director for review. If approved by the Graduate Program Director, the request will be forwarded for approval to the Dean of the Faculty of Mathematics and Science and the Dean of Graduate Studies. The supervisor change may result in an extension to the length of time needed to complete the degree.

5.1. Monitoring of graduate student progress

Graduate students are responsible for convening their supervisory committees for regular meetings. Minimally, supervisory committees should meet at least twice in each year of a student's program. Additional meetings may be called at the request of the student, the supervisor, other members of the committee, the Graduate Program Director, or the Chair of the Department of Physics. A meeting of the supervisory committee should also be held when major changes to a student's program are contemplated, such as a transfer from the MSc into the PhD stream or a major change to the student's research project.

The supervisory committee shall review:

- program course and ancillary requirements;
- performance in courses;
- progress in research;
- performance as a teaching assistant, if appropriate.

The decision of the supervisory committee is by majority, except when the sole dissenting vote is that of the supervisor. If this happens, the supervisory committee will be expanded to hear the case. The Graduate Program Director will add two members of the Physics graduate program, in consultation with the student. The decision of the expanded committee will be that of the majority and final.

In a case when a graduate student's performance has been deemed unsatisfactory, the committee will meet again within six months to evaluate the student's progress. Students will normally be dismissed from the graduate program after two successive meetings of the supervisory committee in which their performance in the program is deemed unsatisfactory. In some circumstances, with an approval of the Graduate Program Director, a student can be dismissed from the program after one unsatisfactory review by the supervisory committee.

Students should be aware that it is their responsibility to make sure their committee meetings take place (unless the meeting is called by the supervisor, other members of the committee, the Graduate Program Director, or the Department Chair). The supervisory committee meetings must be documented with the Graduate Student Progress Report Form (available at the Physics graduate program website, see also Appendix C), which should be brought to the committee meeting by the student.

Each graduate student receiving an external scholarship must also have a satisfactory yearly Graduate Student External Progress Report Form sent to the scholarship agency by the Graduate Studies Office in order to continue receiving external scholarship funding. This form is available from the Graduate Studies website, currently at <http://www.brocku.ca/graduate-studies/current-students/student-forms>

5.2. Proposal of research

All students must present and have approved by their supervisory committee a proposal of research. No later than in the second term of study for a graduate student, the graduate student should organize a meeting of the supervisory committee, in which the proposal of research will be presented. Normally, it will be an oral presentation 20-30 minutes in length,

containing the following information:

- title of the research project;
- project objectives/questions/hypothesis to be researched;
- literature discussion to put the project into context of the current understanding in the research field;
- methodology to be used to answer the research questions;
- course work being currently taken or to be taken over the next year;
- timeline for project objectives.

The student must provide the chair of the supervisory committee with a printed copy of the presentation to be included with the progress report.

6. Ph.D. Comprehensive Exam procedure

The PhD comprehensive exam will test student's knowledge of their research field and related areas of physics, and also their ability to pursue and complete original research at the PhD level.

The comprehensive exam takes place within the first 24 months of the student's PhD program, after all course requirements (except the thesis, the graduate seminars, and the writing course) have been fulfilled. If the student has not completed the course requirements within the first 24 months, the appropriate course of action will be determined by the Graduate Program Director in consultation with the supervisory committee.

The arrangements for the exam are made by the Graduate Program Director, who will form the examination committee and set the examination date. The examination committee consists of two members of the student's supervisory committee, excluding the student's supervisor, and three additional Physics graduate faculty members, one of whom shall serve as Chair of the examination committee.

At least one week prior to the exam, the student must submit to the examination committee a written proposal of research for his/her thesis. The proposal should be about 5 pages in length and contain an abstract, a brief summary of the current status of the field and a literature review, a statement of the research objectives, a description of the methodology, an outline of the progress to date, and a work plan with a timeline.

The examination will consist of an oral presentation by the student about his/her research, around 25-30 minutes in length, followed by questions from the examination committee. The questions of the committee may not necessarily be related to the student's research project, in particular, the examiners may test the student's knowledge of his/her broader research area and also fundamentals from other areas of physics. The total duration of the presentation and the questioning period cannot exceed two hours. When the committee is satisfied with the questioning, the examination chair thanks the student, who then leaves the room so that the committee may deliberate *in camera*.

All five members of the examination committee will vote on the outcome of the exam. The examination committee will award the student either a Pass or Fail grade. The decision of the examination committee shall be that of the majority. All aspects of the student's written proposal of research and his/her performance during the examination will be taken into consideration

when determining the grade.

The decision of the examination committee will be recorded on the PhD Comprehensive Exam Evaluation Form (available at the Physics graduate program website, see also Appendix C) and submitted to the Graduate Program Director.

If failed, the student must repeat the examination within four months. A student who fails twice will be dismissed from the program.

7. Thesis submission procedure

The thesis must conform to the Faculty of Graduate Studies Thesis Format Specifications, currently at <http://www.brocku.ca/graduate-studies/current-students/thesis-procedures>

All typing and other costs of preparing the thesis are the responsibility of the student.

7.1. First draft submission

First draft of the thesis is a complete draft that requires no further research or additional chapters/sections. The first draft can be submitted only after all the course requirements (including, for PhD students, the graduate seminars and the writing course), have been fulfilled. Students with First Draft Status must be deemed by their supervisory committee to be able to complete their degree requirements within the subsequent term.

Once the student has completed a first draft of the thesis and it has been reviewed and approved by the supervisor and the supervisory committee, the student can hand in this first draft to the Graduate Program Director along with the First Draft Form from the Graduate Studies Office (currently at <http://www.brocku.ca/graduate-studies/current-students/student-forms>) to apply for the first draft tuition reduction. Students must be mindful of the Faculty of Graduate Studies deadlines regarding receipt of the First Draft Form.

First Draft Status may only be awarded once and only for one term.

7.2. Internal thesis review

Once the supervisor agrees that the thesis is ready for internal review, each member of the supervisory committee will receive a copy of the thesis to decide if the thesis is ready for external review. The internal review process will normally take no longer than two weeks. Once the student has made the thesis corrections as directed from the internal review, all members of the supervisory committee will sign off indicating that the thesis is ready for external review.

The internal review must be completed and the final draft of the thesis must be submitted to the Graduate Program Director before the end of the last term of the students' program. Students are strongly encouraged to submit the final draft of the thesis at least 4-6 weeks before the end of the last term.

After the final draft of the thesis has been submitted to the Graduate Program Director, the student will be required to deposit with the supervisor all laboratory notebooks, together with all other original data records, spectra, samples, etc. These will be retained as the property of the supervisor or the Brock Department of Physics, as appropriate.

7.3. External thesis review and setting the defence date

Once the thesis has passed the internal review, five copies (MSc) or six copies (PhD) along with an electronic PDF file of the thesis are submitted to the Graduate Program Director. The supervisor, in consultation with the student, must also complete and have approved by the Graduate Program Director a list of three potential external examiners, ranked in order of preference.

For MSc theses, two copies of the thesis along with the list of potential external examiners are forwarded to the Dean of Mathematics and Science. The Dean (or the Dean's designate) will appoint the external examiner and forward a copy of the thesis along with the program's policies for thesis examinations to the external examiner. With the approval of the Dean of Graduate Studies and the Dean of Mathematics and Science, the external examiner may be external to the Physics graduate program, but internal to Brock University.

For PhD theses, two copies of the thesis along with the list of potential external examiners are forwarded to the office of the Dean of Graduate Studies. The Dean (or the Dean's designate) will appoint the external examiner and forward a copy of the thesis along with the program's policies for thesis examinations to the external examiner.

Once the Graduate Program Director and the departmental graduate administrative assistant receive notification of who the external examiner will be, a defence date will be set. The date will normally be no more than 4-6 weeks from the external examiner notification date. The remaining examination committee members will then receive a copy of the thesis for the final defence.

The external examiner shall submit a written evaluation of the thesis to the Graduate Program Director at least one week prior to the defence. It will be identified as part of the report whether the thesis is ready for defence. The external examiner's report will be shared with other members of the examination committee and the student.

For MSc theses, the external examiner may choose not to attend the defence at Brock or via a videolink. In this case, the external examiner's report must

include questions to be addressed to the student during the defence by the Chair of the examination committee.

If the external examiner reports that the thesis is not ready for defence, the student must revise the thesis within a reasonable period of time. The revised thesis must be approved by the supervisory committee and then resubmitted to the external examiner. If the external examiner's evaluation is so unfavourable as to jeopardize the approval of the thesis, the defence should be postponed and the Graduate Program Director, in consultation with the supervisory committee, will recommend a subsequent course of action.

A change of external examiner, in exceptional circumstances, must be justified in writing to the Dean of Mathematics and Science (MSc thesis) or the Dean of Graduate Studies (PhD thesis).

8. Thesis defence

Graduate thesis defences will normally be open defences. A request for a closed defence must be approved by the Dean of Mathematics and Science and the Dean of Graduate Studies and will be based on certified medical or compassionate grounds.

8.1. Examination committee composition

The MSc examination committee will consist of the Dean of the Faculty of Mathematics and Science (or the Dean's designate), who will serve as the non-voting chair of the examination committee, the external examiner, the supervisor, and two faculty representatives from the Physics graduate program appointed by the Graduate Program Director (normally the other two members of the supervisory committee). With a prior approval of the Dean of the Faculty of Mathematics and Science, the external examiner does not have to be physically present at the defence, participating in the proceedings, *e.g.*, via a videolink.

The PhD examination committee will consist of the Dean of Graduate Studies (or the Dean's designate), who will serve as the non-voting chair of the examination committee, the external examiner, an internal external examiner (from within Brock University but outside the Physics graduate program) nominated by the Graduate Program Director, the supervisor, and two faculty representatives from the Physics graduate program appointed by the Graduate Program Director (normally the other two members of the supervisory committee).

8.2. Format of defence

The defence will consist of three parts: (1) a research presentation by the candidate, (2) a questioning period, and (3) an *in camera* meeting of the examination committee. The parts (1) and (2) are open to the public.

- 1.** Examination chair introduces the committee members and the candidate, explains the format of the defence. The candidate gives a presentation, around 30-35 minutes in length, followed by questions from the audience, including the members of the examination committee.
- 2.** After a short (around 10-15 minutes) break, an oral examination session is held, during which only the members of the examination committee may ask questions.

Order of questioning is usually the external examiner, followed by the internal external examiner (for PhD thesis defence only), first member of the supervisory committee (the supervisory committee chair), second member of the supervisory committee, the supervisor. The chair of the examination committee is not required to participate in the questioning period. The duration of the questioning period cannot exceed two hours.

3. When the committee is satisfied with the questioning, the examination chair thanks the candidate and the audience, who then leave the room so that the committee may deliberate *in camera*.

8.3. Possible outcomes of the defence

All members of the examination committee, excluding the chair, will vote on the outcome of the defence, for a total of 4 votes (MSc defence) or 5 votes (PhD defence). All aspects of the written work as well as the student's performance during the defence will be taken into consideration when determining the grade.

The examination committee will award the thesis either a Pass or Fail grade. A Pass grade will be further differentiated as one of: Acceptable as is, Acceptable with minor revisions, Acceptable with major revisions.

The decision of the examination committee shall be that of the majority, except when the external examiner casts a dissenting vote. If this happens, it must be reported to the Dean of Graduate Studies, who in consultation with the Dean of Mathematics and Science will determine an appropriate course of action. In the event of a tie vote, the vote of the external examiner will determine the outcome of the exam.

If revisions are necessary, the examination committee will specify the areas for revision and the date by which the revised thesis is to be returned to the Graduate Program Director. The date will normally be within four weeks of the defence. Note that the final revised version of the thesis must be received by the Faculty of Graduate Studies no later than 56 days since the end of the student's last term, otherwise the student will be required to register for an additional term.

If a Fail grade is awarded for the thesis, the student will be withdrawn from the program.

9. E-Thesis submission

The final version of the thesis must be approved by the supervisory committee.

The student must submit the final version of the thesis to the Faculty of Graduate Studies electronically, following the E-Thesis submission guidelines, currently at <http://brocku.ca/graduate-studies/current-students/thesis/e-thesis-submission>

10. Academic misconduct policies

The University policies and procedures covering academic misconduct, currently at <http://www.brocku.ca/academicintegrity/> and <http://www.brocku.ca/webcal/current/graduate/acad/>, apply also to the Physics graduate program.

Please note that an act of academic misconduct constitutes sufficient grounds for dismissal from the program.

11. Conflict resolution for graduate students

If a graduate student encounters a conflict that cannot be resolved with their supervisor, the graduate student should inform the Graduate Program Director of the problem and the Graduate Program Director will try to facilitate a satisfactory resolution to the conflict.

If the student's supervisor is the Graduate Program Director, the conflict should be directed to the Chair of the Department, who will try to facilitate a satisfactory resolution to the conflict.

If a satisfactory resolution to the conflict is not reached, the Department will contact the Dean of the Faculty of Mathematics and Science for assistance in resolving the problem, after which, the Dean's Office will decide the course of action to be taken.

12. Useful links

2010-11 Graduate Calendar: <http://www.brocku.ca/webcal/2010/graduate/>

Academic regulations and University policies:
<http://www.brocku.ca/webcal/2010/graduate/acad.html>

Code of Student Conduct:
<http://www.brocku.ca/webcal/2010/graduate/code.html>

Other University policies (e.g. governing IT use):
<http://www.brocku.ca/university-secretariat/policies>

Graduate Studies academic regulations from the Faculty Handbook:
http://www.brocku.ca/university-secretariat/facultyhandbook/section3#_genIndex85

Appendix A: Course descriptions

Not all courses are offered in every academic year. Students must check to ensure that prerequisites for the courses are met. Students may be de-registered, at the request of the instructor, from any course for which prerequisites and/or restrictions have not been met.

PHYS 5F90 **MSc Thesis**

An original research project involving the preparation and defence of a thesis which will demonstrate a capacity for independent work. The research shall be carried out under the supervision of a faculty member and the thesis defended at an oral examination.

PHYS 5N01 **Scientific Writing**

(also offered as CHEM 5N01)

The organizational and stylistic skills of writing and referencing a scientific document. Examples from the various literature forms such as primary journals, reviews, reports, and theses, as well as presentations and seminars. Database use and reference citation, and use of figures and graphs to illustrate data.

Note: This course is taught by instructors from the Brock Student Development Centre.

PHYS 5P00 **Quantum Chemistry: Theory**

(also offered as CHEM 5P00)

Self-consistent-field (SCF) method: configuration interaction; basis functions; electron correlation; physical properties of atoms, diatomic and polyatomic molecules.

PHYS 5P02 **Membrane Biophysics**

The structure of biological membranes, including their fluctuations, dynamics, and interactions. Lipids, their variety and purpose, especially for biotechnology. Membrane proteins, including introduction to ion channels and simple models of excitable membranes. Biophysical experimental methods for the study of membranes.

PHYS 5P30

Advanced Electromagnetism

Electromagnetic wave propagation in vacuum, dielectrics, conductors, and ionized gases; wave guide and transmission line propagation; dipole and quadrupole radiation fields; relativistic transformation of the electromagnetic fields; radiation by moving charges.

PHYS 5P41

Advanced Statistical Physics

Statistical ensembles; mean field and Landau theory, critical phenomena, and the renormalization group; quantum fluids; superfluidity; selected topics on disordered systems.

PHYS 5P50

Advanced Quantum Mechanics I

Angular momentum, rotations, and scalar and vector operators, selection rules; Pauli principle and periodic table; nuclear shell model; degenerate perturbation theory; electron in magnetic field, Landau levels; time evolution in quantum mechanics, time-dependent perturbation theory; elastic scattering.

PHYS 5P51

Advanced Quantum Mechanics II

Propagators and Green's functions; path integral formalism; functional integrals and derivatives; systems of identical particles and second quantization; relativistic quantum mechanics.

Prerequisite: PHYS 5P50

PHYS 5P64

Introduction to Mathematical Physics

(also offered as MATH 5P64)

Calculus of variations, least action principle in physics, symmetries and conservation laws, main differential-geometric structures (differential form, vector field, Riemannian metric). Applications to physics: electro-magnetic field as a one-form, gravity as a pseudo-Riemannian metric. Introduction to mathematical ideas of quantum mechanics.

PHYS 5P67

Biophysical Techniques

(also offered as BIOL 5P67, BTEC 5P67, and CHEM 5P67)

An advanced seminar/lecture course on experimental techniques in biophysics. The focus is on understanding the theory, applications and

limitations of a variety of techniques students will encounter during their graduate studies. Techniques will range from advanced spectroscopy (absorption, fluorescence, NMR, X-ray diffraction) to molecular biochemistry spectroscopy.

PHYS 5P70

Advanced Condensed Matter Physics

Energy bands in metals, semiconductors, and insulators; lattice dynamics; electrical, magnetic, thermal, optical, and transport properties of solids.

PHYS 5P71

Special Topics in Condensed Matter Physics

Long-range order in condensed matter systems: charge and spin density waves, etc; strongly-correlated electron systems; quantum Hall effect; metal-insulator transitions; other topics to be selected by the instructor.

PHYS 5P72

Many-Body Theory

Green's functions at zero and finite temperature; perturbation theory and Feynman diagrams; linear response theory; electron-electron and electron-phonon interactions; electrons in disordered systems; Fermi liquid theory; introduction to BCS theory of superconductivity.

PHYS 5P73

Superconductivity I

Overview of basic experimental facts; London theory; BCS theory; symmetry of the order parameter; Ginzburg-Landau theory and magnetic properties of superconductors; quasiparticle excitations in superconductors: thermal and transport properties; macroscopic phase coherence phenomena.

PHYS 5P74

Magnetism and Magnetic Materials

Fundamental and device applications of magnetism will be explored. Magnetic materials and magnetic measurements; domains, domain walls, domain processes, magnetization curves, and hysteresis; soft and hard magnetic materials and applications; magnetic recording; new developments and recent progress: magnetic multilayer structures, granular magnetic thin films, and giant magnetoresistance.

PHYS 5P75

Optical Properties of Solids

Measurement techniques; reflectivity, the dielectric function and the optical

conductivity; Lorentz-Drude oscillator model; Kramers-Kronig transformations and sum rules; properties of metals, insulators, and superconductors.

PHYS 5P76

Nuclear Magnetic Resonance

Density matrix formulation of NMR theory; spectroscopy of simple spin systems and spin-dependent interactions; relaxation theory; spin temperature; dipolar broadening in solids; NMR of soft condensed matter systems; practical aspects of high-fidelity solid-state NMR; NMR spectrometer design; NMR imaging and microscopy.

Prerequisite: PHYS 5P50

PHYS 5P77

Superconductivity II

Field-theoretical methods in superconductivity. Gor'kov equations; strong-coupling theory; tunnelling; unconventional superconducting materials: high-temperature superconductors, heavy fermion, magnetic, and organic superconductors.

Prerequisite: PHYS 5P73

PHYS 5P78

Electronic Structure of Periodic and Aperiodic Systems

Density Functional and related theories; survey of (semi)empirical and first-principles electronic structure methods; electronic structure of liquid metals, metallic glasses, random alloys, and quasicrystals; effective medium theories, coherent potential, and other approximations; recursion and other real-space methods.

PHYS 5P79

Experimental Methods in Condensed Matter Physics

Survey of experimental methods commonly used in condensed matter physics: optical and NMR spectroscopy, SQUID magnetometry, neutron and X-ray scattering, low-temperature and high-pressure technology. The techniques presented will vary. Designing experiments with advanced equipment and critical analysis of the results on both statistical and methodological grounds.

PHYS 5P91

Graduate Seminar I

Independent study and presentation of major research papers in the area of specialization. Each student is required to attend and participate in all

seminars given by students registered in the course. Students are also required to attend at least 80% of the Departmental seminars.

PHYS 7F90

PhD Thesis

An original research project involving the preparation and defence of a thesis which will demonstrate a capacity for independent work. The research shall be carried out under the supervision of a faculty member and the thesis defended at an oral examination.

PHYS 7P91

Graduate Seminar II

Independent study and presentation of major research papers in the area of specialization. Each student is required to attend and participate in all seminars given by students registered in the course. Students are also required to attend at least 80% of the Departmental seminars.

Appendix B: Graduate student forms

- 1. Graduate Student Progress Report**
- 2. Request to Transfer from MSc to PhD**
- 3. PhD Comprehensive Exam Evaluation Form**

**DEPARTMENT OF PHYSICS
GRADUATE STUDENT PROGRESS REPORT**

Name of student: _____ **Date:** _____

Field of specialization: _____

MSc PhD **Date enrolled:** _____

Supervisory Committee:

Supervisor 1st Member (Chair) 2nd Member

Date by which all work, including thesis defense, must be completed: _____

Progress in the program: _____

Report period: Year 1 Year 2 Year 3 Year 4 Year 5

RECOMMENDATION OF COMMITTEE:

- Student's progress is satisfactory (give details if there are causes for concern)
- Student's progress is unsatisfactory (give details), next meeting within _____ months
- Student's progress is unsatisfactory (give details), dismissal from the program is recommended

Signatures of Committee:

Supervisor

1st Member (Chair)

2nd Member

Student: I have seen this report:

- I agree I disagree with part or all of it
and am attaching my comments

(Student Signature)

**DEPARTMENT OF PHYSICS
REQUEST TO TRANSFER FROM MSC TO PHD**

Name of student: _____ **Number:** _____

Field of specialization: _____

Date enrolled: _____ **Transfer date requested:** _____

Courses taken in MSc program:	Term:	Marks:
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Signature of student: _____ **Date:** _____

Supervisory Committee:

Supervisor 1st Member (Chair) 2nd Member

RECOMMENDATION OF COMMITTEE:

- Transfer recommended**
- Transfer not recommended (give details)**

Signatures of Committee:

Supervisor

1st Member (Chair)

2nd Member

Date

**DEPARTMENT OF PHYSICS
PhD COMPREHENSIVE EXAM EVALUATION FORM**

Name of student: _____ **Number:** _____

Field of specialization: _____

Date enrolled in PhD program: _____

Date of examination: _____

Grade awarded (Pass or Fail): _____

Comments: _____

EXAMINATION COMMITTEE:

_____ Chair	_____
_____	_____
_____	_____
_____	_____
_____	_____
(signatures)	(print names)