

2019 Polytechnique Montréal Summer Research Internship Programme

Research Internship Programme:

9 research projects will be offered. Please refer to pages 2 to 11 for the programme brochure and project description of each project.

Duration: a minimum of 4 months (between May and August 2019)

Required Documents for Application:

- Letter of motivation including the following information (if you have selected 2 research projects, provide a letter of motivation for each project and state the research project title clearly in the letter);
 - explanations of your interest in working in the selected project
 - your skills in respect to the project
- Curriculum Vitae (CV);
- Copy of your most recent academic transcript;
- If possible, a copy of an internship report made in the past.

Application Deadline: 3 December 2018

Please pay attention to the area of expertise when you are selecting the research project(s).

If you are interested to apply, please send the above required documents to Ms Carrie Cheung via email (carriews.cheung@polyu.edu.hk) on/before the application deadline. For enquiries, please contact Ms Cheung at 3400 3185.

Thank you for your kind attention.

Regards

Department of Industrial and Systems Engineering

2019 POLYTECHNIQUE MONTRÉAL SUMMER RESEARCH INTERNSHIP

POLYTECHNIQUE
MONTRÉAL
TECHNOLOGICAL
UNIVERSITY



Founded in 1873, **Polytechnique Montréal** is a leading Canadian university for the scope and intensity of its engineering research and industrial partnerships. It is ranked #1 for the number of Canada Research Chairs in Engineering, the most prestigious research funding in the country, and is also first in Québec for the size of its student body and the scope of its research activities. Polytechnique Montréal has laboratories at the cutting edge of technology thanks to funding of nearly a quarter of a billion dollars from the Canada Foundation for Innovation over the past 10 years. In 2017, Montreal ranked 1st for *best student cities*! Come and experience the pleasures of a fantastic summer in Québec where there is no time to be bothered with all the festivals!

Research Internship Program

A research internship is a research activity that is an integral part of a visiting student's academic program at the home institution. Each year, Polytechnique's research units welcome more than 250 students from other universities wishing to put into practice the technical and scientific knowledge acquired in their studies. The research conducted is supervised by a professor of Polytechnique and is always related to needs expressed by society or companies, and can be made in laboratories or *in situ*.

Duration

The recommended duration of the internship is a minimum of 4 months, usually taking place between May and August 2019. Once the admission to the program has been confirmed, no change in the duration and the dates can be made. Please confirm the research duration with your home institution supervisor before application.

Financial Arrangement

- Tuition fee waiver for the duration of the internship;
- Free transportation from the airport to your place of residence upon your arrival;
- Employer Compliance Fee of \$230 CAD covered by Polytechnique Montréal (once the internship is confirmed, the work permit applicant must pay the requested immigration fee).

Outstanding candidates may receive one of the 15 scholarships available! Amount of the scholarship: \$1000 CAD per month for a maximum of 4 months.

Eligibility Criteria

- Being enrolled in one of Polytechnique Montréal's partner universities;
- Having completed at least two years of an engineering undergraduate program or at least one year of a graduate program (Master or Ph.D.) according to projects' requirements as described in the following pages;
- Having a minimum GPA of 2.75 out of 4;
- Meet the specific skills required by the supervisor if any;
- Being fluent in French or in English (no language proficiency test is required).

Required Documents for Application (in French or in English)

- Application Form;
- Letter of motivation including the following information (if you have selected 2 research projects, provide a letter of motivation for each project):
 - explanations of your interest in working in the selected project
 - your skills in respect to the project
- Curriculum vitae (CV);
- Copy of your most recent academic transcript;
- Proof of a full-time enrollment from your home institution (the letter must confirm that you are currently enrolled in a full-time program and will continue to be enrolled upon your return);
- If possible, a copy of an internship report made in the past.

To enhance your chances to be selected, choose 2 research projects. It can be 2 research projects from the list or 1 research project from the list and 1 supervisor from the Directory of Expertises!

Application Deadline

All documents must be sent electronically by **January 15, 2019** to the International Relations Office of Polytechnique Montréal: brin@polymtl.ca. Please specify in the subject "2019 Summer Research Internship Program". Note that a conference call via Skype may be organized if needed for final selection.

Announcement

The results will be announced in February 2019 to each candidate. Selected candidates will receive an "Offer of Employment to a Foreign National Exempt from a Labour Market Impact Assessment (LMIA)" and will have to apply for a Work Permit at the Canadian Visa office that serves the area they live in. It is possible that the new Public Policy – Short-term (120) work permit exemption for researchers will allow you to be exempted from a work permit.

For any question regarding your application, please contact:
International Relations Office ■ brin@polymtl.ca

PROJECT DESCRIPTION

2019 Summer Research Internship Scholarship Program

Area of Expertise :	<input type="checkbox"/> Aerospace <input checked="" type="checkbox"/> Biomedical <input type="checkbox"/> Chemical <input type="checkbox"/> Civil, Geological, Mining <input checked="" type="checkbox"/> Computer/Software <input type="checkbox"/> Electrical <input checked="" type="checkbox"/> Mathematics/Industrial <input checked="" type="checkbox"/> Mechanical <input type="checkbox"/> Physics
Research Project Title : <i>(max. 10 words)</i>	Biothermodynamics Applied to Biomechanics
University Cycle :	<input type="checkbox"/> 1 st cycle (Undergraduate) <input checked="" type="checkbox"/> 2 nd cycle (Master) <input checked="" type="checkbox"/> 3 rd cycle (Ph.D.)
Background Information: <i>(max. 100 words)</i>	Biomechanics, Thermodynamics, complex systems, maths relative to spine, locomotion and low back pain.
Tasks during the Internship: <i>(max. 50 words)</i>	Develop a mathematical model for the spine
Required Skills for the Internship: <i>(max. 50 words)</i>	Thermodynamics, maths. Person with leadership and team player skills, autonomous, motivated and with good communications.
Location:	<input checked="" type="checkbox"/> Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) <input type="checkbox"/> Others, please specify: Name: Address:
Supervisor:	Name: L'Hocine YAHIA Title: Full Professor Department: Mechanical Engineering Website: https://www.polymtl.ca/liab/en

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Research Project Title : <i>(max. 10 words)</i>	Regulation and Standard Processes for Dental Devices: a Pathway to Market
University Cycle :	<input checked="" type="checkbox"/> 1 st cycle (Undergraduate) <input checked="" type="checkbox"/> 2 nd cycle (Master) <input checked="" type="checkbox"/> 3 rd cycle (Ph.D.)
Background Information: <i>(max. 100 words)</i>	Medical devices marketed in the United States and in Canada are subject to the regulatory controls in the FDA and Santé Canada. Dental innovations developed in the laboratory will need to be validated through proper standards (ISO 11609) and approved by regulatory instances.
Tasks during the Internship: <i>(max. 50 words)</i>	Management, protection and exploitation of intellectual property assets. Develop a methodology of validation and approval. Write a patent or an application for homologation.
Required Skills for the Internship: <i>(max. 50 words)</i>	Ability to analyze and synthesize, rigor and precision. Assets: Knowledge of regulation and standards Person with leadership and team player skills, autonomous, motivated and with good communications.
Location:	<input checked="" type="checkbox"/> Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) <input type="checkbox"/> Others, please specify: Name: Address:
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Research Project Title : <i>(max. 10 words)</i>	Innovation in Toothbrush Design Life Cycle
University Cycle :	<input checked="" type="checkbox"/> 1 st cycle (Undergraduate) <input checked="" type="checkbox"/> 2 nd cycle (Master) <input checked="" type="checkbox"/> 3 rd cycle (Ph.D.)
Background Information: <i>(max. 100 words)</i>	The production of toothbrushes synthetic materials used in the industry has gone a long way. Most toothbrushes are made with plastics such as polyethylene, polypropylene and nylon bristles. The problem is that the use of plastics are not environment friendly. The aim of this project is to develop an innovative work flow process that will include recycling or compost.
Tasks during the Internship: <i>(max. 50 words)</i>	Design a toothbrush life cycle (methodology, solution, equipment) Develop a preliminary work flow. Optimize the process.
Required Skills for the Internship: <i>(max. 50 words)</i>	3D printing, Work flow processes, device life cycle. Person with leadership and team player skills, autonomous, motivated and with good communications.
Location:	<input checked="" type="checkbox"/> Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) <input type="checkbox"/> Others, please specify: Name: Address:
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Research Project Title : <i>(max. 10 words)</i>	Advancing the Field of 3D Biomaterial Printing for Dental Application
University Cycle :	<input checked="" type="checkbox"/> 1 st cycle (Undergraduate) <input checked="" type="checkbox"/> 2 nd cycle (Master) <input checked="" type="checkbox"/> 3 rd cycle (Ph.D.)
Background Information: <i>(max. 100 words)</i>	The aim of present work is to develop a semisolid antibacterial preparation for 3D printing.
Tasks during the Internship: <i>(max. 50 words)</i>	Develop a working methodology Develop a preliminary formulation Optimization.
Required Skills for the Internship: <i>(max. 50 words)</i>	Microbiology, Polymers, 3D printing knowledge. Person with leadership and team player skills, autonomous, motivated and with good communications, creativity, positive thinking.
Location:	<input checked="" type="checkbox"/> Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) <input type="checkbox"/> Others, please specify: Name: Address:
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Research Project Title : <i>(max. 10 words)</i>	High Performance Computing and Simulation of Fluid Flow
University Cycle :	<input checked="" type="checkbox"/> 1 st cycle (Undergraduate) <input checked="" type="checkbox"/> 2 nd cycle (Master) <input type="checkbox"/> 3 rd cycle (Ph.D.)
Background Information: <i>(max. 100 words)</i>	The latest advances in computers and the multi-core parallel CPUs (Central processing units) and GPUs (graphics processing units) technologies has provided a unique opportunity for real-life large-scale simulation many fluid flow problems (with a scale ranging from global ocean circulation to flow in a nano-tube). The purpose of this project is to take advantage of such computational powers by developing the high-performance parallel codes and tools for simulation of complex fluid flows, with a focus on water and hydro-environmental problems.
Tasks during the Internship: <i>(max. 50 words)</i>	Contributing to (1) the parallelization of an existing mesh-free fluid simulation code on either parallel CPUs (using MPI programming library) or GPUs (using CUDA-C library) and (2) simulation and study of example hydro-environmental fluid problems
Required Skills for the Internship: <i>(max. 50 words)</i>	Required: Basic knowledge of shared/distributed memory parallel programming, and familiarity with C++ language, and CUDA-C and/or MPI libraries. Desired (NOT mandatory): Knowledge of the numerical methods and computational fluid dynamics
Location:	<input checked="" type="checkbox"/> Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) <input type="checkbox"/> Others, please specify: Name: Address:
Supervisor:	Name: Ahmad SHAKIBAEINIA Title: Assistant Professor Department: Civil, Geological and Mining Engineering Website: http://www.polymtl.ca/expertises/en/shakibaeinia-ahmad

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Research Project Title : <i>(max. 10 words)</i>	Automatic Detection of Convexity for Optimization
University Cycle :	<input checked="" type="checkbox"/> 1 st cycle (Undergraduate) <input checked="" type="checkbox"/> 2 nd cycle (Master) <input checked="" type="checkbox"/> 3 rd cycle (Ph.D.)
Background Information: <i>(max. 100 words)</i>	Modeling languages for optimization translate the mathematical description of objective functions and constraints to computational graphs for purposes of efficient evaluation and differentiation. The same computational graphs could be used to automatically detect convexity and other properties of the functions involved, and thus determine properties of the optimization problem. Knowledge of such properties about a problem can aid in modeling and in selecting an appropriate solver for the problem. In this project, we will work with the Julia programming language (julialang.org) and the JuMP modeling language for optimization (juliaopt.org).
Tasks during the Internship: <i>(max. 50 words)</i>	Acquire a solid understanding of how JuMP stores the computational graphs associated to a problem and how they can be accessed and examined. Based on prior work using other modeling languages, implement automatic discovery rules, including convexity, linearity, quadraticity, etc.
Required Skills for the Internship: <i>(max. 50 words)</i>	Excellent programming skills and fluency in the Julia language are required. An understanding of computational graphs and optimization help but are not required.
Location:	<input checked="" type="checkbox"/> Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) <input type="checkbox"/> Others, please specify: Name: Address:
Supervisor:	Name: Dominique ORBAN Title: Associate Professor Department: Mathematics and Industrial Engineering Website: https://dpo.github.io/

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Research Project Title : <i>(max. 10 words)</i>	Automatic Detection of Partially-Separable Structure
University Cycle :	<input type="checkbox"/> 1 st cycle (Undergraduate) <input checked="" type="checkbox"/> 2 nd cycle (Master) <input checked="" type="checkbox"/> 3 rd cycle (Ph.D.)
Background Information: <i>(max. 100 words)</i>	<p>In practice, the objective and constraints of optimization problems are often partially separable, i.e., compositions of simpler functions that only depend on a small subset of variables. Exploiting such structure improves efficiency, both in gradient-based and derivative-free solvers. Modeling languages translate the description of objective functions and constraints to computational graphs for purposes of efficient evaluation and differentiation. The modeler does not typically specify the partially-separable structure. By walking the computational graph of a function, we may detect it automatically and transmit it to solvers. In this project, we will work with the Julia programming language (julialang.org) and the JuMP modeling language for optimization (juliaopt.org).</p>
Tasks during the Internship: <i>(max. 50 words)</i>	<p>Acquire a solid understanding of how JuMP stores the computational graphs associated to a problem and how they can be accessed and examined. Based on prior work using other modeling languages, implement automatic detection of partially-separable structure in computational graphs.</p>
Required Skills for the Internship: <i>(max. 50 words)</i>	<p>Excellent programming skills and fluency in the Julia language are required. An understanding of computational graphs is recommended. Proficiency in optimization helps but is not required.</p>
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Research Project Title : <i>(max. 10 words)</i>	Efficient Solution of Ill-Posed Optimization Problems
University Cycle :	<input type="checkbox"/> 1 st cycle (Undergraduate) <input checked="" type="checkbox"/> 2 nd cycle (Master) <input checked="" type="checkbox"/> 3 rd cycle (Ph.D.)
Background Information: <i>(max. 100 words)</i>	<p>Certain optimization problems in economics have numerous redundant constraints, which causes typical solvers to run into numerical difficulties. The recent NCL solver, tailored to a specific tax problem, combines the AMPL modeling language and either the IPOPT or KNITRO solvers, works around such difficulties but is currently a serial code. The first part of this internship consists in arranging so NCL can exploit multi-core architectures and solve larger problems. The second part of this internship consists in implementing a robust general-purpose NCL that is not limited to the tax problem. The latter will be done using the Julia programming language (julialang.org) and the optimization infrastructure developed in my research group.</p>
Tasks during the Internship: <i>(max. 50 words)</i>	<p>Acquire an understanding of the NCL algorithm and its relation to the classical augmented Lagrangian algorithm. Arrange for AMPL to instruct IPOPT and KNITRO to take advantage of multiple cores. Develop a Julia version of NCL based on IPOPT or KNITRO and benchmark it on large collections of problems.</p>
Required Skills for the Internship: <i>(max. 50 words)</i>	<p>Intermediate knowledge of constrained optimization and in particular the augmented Lagrangian algorithm. Basic knowledge of AMPL helps but is not necessary. Good knowledge of the Julia language is recommended. Solid computer proficiency (Linux or macOS) is required.</p>
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Research Project Title : <i>(max. 10 words)</i>	Infrastructure of the GALAHAD Library for Optimization
University Cycle :	<input checked="" type="checkbox"/> 1 st cycle (Undergraduate) <input checked="" type="checkbox"/> 2 nd cycle (Master) <input checked="" type="checkbox"/> 3 rd cycle (Ph.D.)
Background Information: <i>(max. 100 words)</i>	The recently open-sourced GALAHAD library for optimization (https://github.com/ralna/GALAHAD) contains a collection of solvers tailored to several problem structures. Implemented in Fortran 2008, the library does not currently interface well with languages such as C or interpreted languages such as Julia. The objective of the internship is to develop ISO_C_BINDINGS interfaces to one or several GALAHAD modules so as to make them interoperable with other languages. In particular, a Julia interface to GALAHAD is very desirable.
Tasks during the Internship: <i>(max. 50 words)</i>	Acquire an understanding of the structure of the GALAHAD library and how to install it. Develop ISO_C_BINDINGS interfaces to one or several module and implement a Julia interface to those modules.
Required Skills for the Internship: <i>(max. 50 words)</i>	Solid knowledge of modern dialects of Fortran. General computer proficiency (Linux or macOS) is required.
Location:	<input checked="" type="checkbox"/> Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) <input type="checkbox"/> Others, please specify: Name: Address:
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