POLYTECHNIQUE
MONTRÉAL

RESEARCH INTERNSHIP PROGRAM

POLYTECHNIQUE
MONTRÉAL

TECHNOLOGICAL
UNIVERSITY

UT TENSIO SIC VIS

SUMMER 2023

Polytechnique Montréal at Université de Montréal is one of Canada's leading applied-research engineering schools. Highly ranked for the number of Canada Research Chairs in Engineering and the scope of its research activities, Polytechnique obtains the highest research funding among engineering schools in the country. Founded in 1873, Polytechnique Montréal has the largest engineering student body in Quebec. Thirty percent of undergraduates are women. The world needs creative and innovative engineers more than ever. Polytechnique is producing them, in Montreal – ranked among the top student cities in the world for the last 5 years!

RESEARCH INTERNSHIP PROGRAM

A research internship is an integral part of an international student's academic program at the home institution. Every year, Polytechnique's research units welcome over 250 students from other universities wishing to put into practice the technical and scientific knowledge acquired in their studies. The research conducted, respectful of the health and safety measures issued by the Public Health Agency, and supervised by a Polytechnique professor, emanates from a real societal or industrial need, and is carried out in the lab or *in situ*.

DURATION

The recommended duration of the internship is 4 months, with 6 possible starting dates between April and July. Once the admission to the program has been confirmed, no change in the duration or the dates can be made. Please confirm the research duration with your home university Program Coordinator before applying. Note that it is a full-time research internship on our campus (7 hours a day, 35 hours a week).

FINANCIAL ARRANGEMENT

- Tuition fees waiver at Polytechnique Montréal for the duration of the internship;
- Refund of your bus/taxi fare from the airport to your place of residence upon your arrival;
- If applicable, Employer Compliance Fees of $230 CAD covered by Polytechnique Montréal (once the internship is confirmed, the work permit applicant must pay the requested immigration fees).

Outstanding candidates may receive one of the 15 scholarships available! Maximum amount of the scholarship: 6,000 CAD for 4 months (prorated at 1 500 CAD/month).

ELIGIBILITY CRITERIA

- Enrolled in one of Polytechnique Montréal's partner universities
- Be officially nominated by your home university International Relations Office or your Internship Office
- 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
- Enrolled in a full-time program and will continue to be enrolled after your internship
- Minimum GPA of 2.75 out of 4 (or equivalent)
- Meet the required skills for the internship
- Be fluent in English or in French (no language test required)
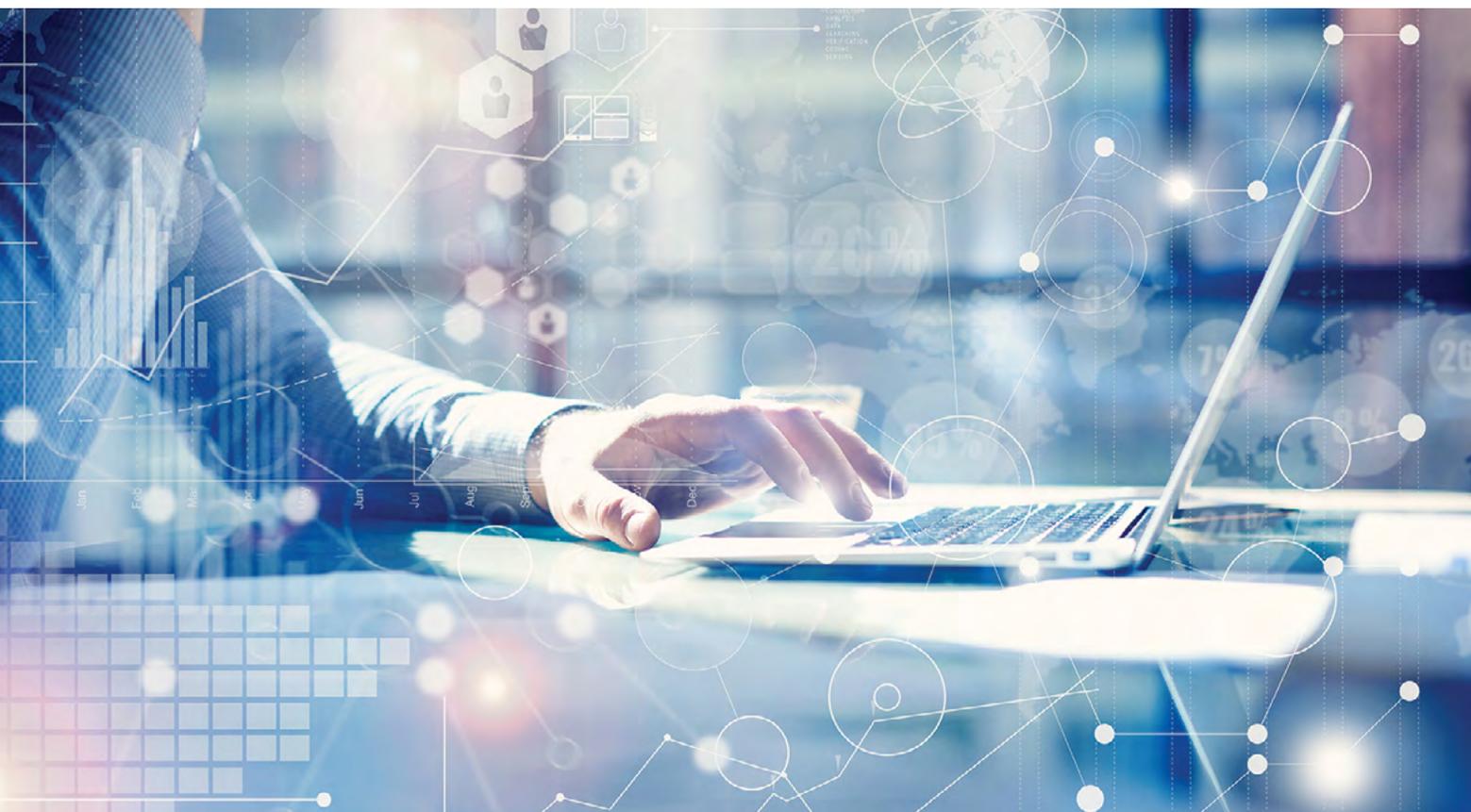
REQUIRED DOCUMENTS FOR APPLICATION

- Online Application Form;

- Copy of your most recent academic transcript clearly stating your GPA or cumulative average;

- Proof of full-time enrollment from your home institution (the letter must be on official letterhead, dated within the last six months and confirm that you are currently enrolled in a full-time program and will continue to be enrolled after your internship);

- Letter of motivation including:
  - name of professor;
  - title of the project;
  - your interest in working in the selected project;
  - your skills in respect to the project.

  If you have selected 2 research projects, provide a letter of motivation for each project.

- Copy of your passport;

- Curriculum vitae (CV);

- If available, a copy of an internship report made in the past.

> To enhance your chances to be selected, choose 2 research projects (from the list or 1 research project from the list and 1 supervisor from the Directory of Expertise)

APPLICATION PROCEDURE

Click **here** to apply and send all required documents by February 1, 2023.

Note that an online conference call may be organized for final selection.

ANNOUNCEMENT

The results will be announced in mid-February 2023 to all participating universities' Program Coordinators. Selected candidates will receive an official Invitation Letter necessary to undertake their immigration procedure according to their status. Note that we encourage the Short-term (120 days) work permit exemption for researchers.

LIST OF RESEARCH PROJECTS

AEROSPACE ENGINEERING

1. Machine-Learning Accelerated Structural Optimization
2. Improving an open source flight controller firmware for autonomous drones
3. Multi-Robot Planetary Exploration System
4. 3D printing sensors on heart models
5. Design and build a simple Voltage-to-Current Converter
6. Machine learning to study heart behavior patterns
7. Optimisation of 3D printed piezoelectric sensors
8. Digital twin for hydroelectric generating unit
9. Drag reduction by elastic reconfiguration of a flat plate in a wind tunnel
10. Improvements to an LBM multicomponent MATLAB code for fluid dynamics
11. Additive manufacturing (3D printing) of composites and multifunctional devices

BIOMEDICAL ENGINEERING

12. An Impact Rig for Replicating Fall Conditions in Elderly
13. Gaze Estimation-Based Assistive Robotic Arm Interface
14. Intelligent conversational agent to support people with chronic conditions: MARVIN
15. Unsupervised Machine Learning Algorithm for Abnormal Movement Detection in Elderly
16. Co-axial non toxic collagen/PCL electrospinning
17. Blood-based brain cancer recurrence detection using optical spectroscopy
18. Tumor detection using depth-resolved biomolecular spectroscopy imaging
19. Design of an orthopedic brace for adolescent idiopathic scoliosis with tunable stiffness
20. 3D electrochemical biosensor for the detection of bacteria in Prosthetic Joint Infection
21. Adhesive surfaces for soft tissue binding
22. Calcium Expression of Cells from Fractured Mice Femurs following Cold-Therapy
23. Synergistic Properties of Parathyroid Hormone & Cold-Therapy on Calcium Pathways
24. Design and prototyping of a semi-active ankle exoskeleton
25. Design of a control system for a pediatric exoskeleton robot
26. Development of Robotic Force/Torque Sensor
27. Modeling, Simulation and Analysis of a gait exoskeleton in the Float system
28. Real-time Quantification of Muscle Forces
29. Re-design of a Robotic Arm To Assist Patients with Musculoskeletal Disorders

CHEMICAL ENGINEERING

30. Development of numerical models to simulate granular flows
31. Enhancing heat transfer through 3d printed lattice structure
32. Understanding the hydrodynamics of particle swarms through simulation
33. Fabrication and characterization of printed stretchable devices
34. Hydrogels for epidermal electronics
35. Kirigami Bioelectronics
36. Neuromorphic Organic Electrochemical Transistors
37. PEDOT electrodeposition using a biocompatible polyanion
38. Self-healable, stretchable and conductive polymers for wearable electronics
39. Surface engineering of materials

CIVIL, GEOLOGICAL AND/OR MINING ENGINEERING

40. Study of bioaerosols from wastewater treatment processes
41. UHPFRC : From material development to structural applications.
42. Soil erosion in vineyards in the context of climate change
43. Crack propagation in geomaterials in reduced gravity conditions
44. Geotechnical Design Paradigms in Reduced Gravity Conditions
45. Co-disposal of waste rock and mine tailings
46. Mechanical behavior of coarse mine waste rock

COMPUTER AND SOFTWARE ENGINEERING

47. Collaborative Simultaneous Localization And Mapping

ELECTRICAL ENGINEERING

48. A.I.-control of neurostimulation interfaces
49. Neuroprosthesis to reverse paralysis after spinal cord injury
50. Privacy-preserving data analysis
51. Combinatorial Optimization for Geospatial Wind Turbine Placement
52. Novel optical fiber sensor development and applications
53. Novel photonic devices and integration by laser fabrication techniques

ENGINEERING PHYSICS

54. Optimality in photonic design
55. Algorithms for 3D nanoscale tracking
56. Flow-based 3D imaging of cells for diagnostics
57. How to defeat bacterial biofilms?

MATHEMATICS AND INDUSTRIAL ENGINEERING

58. Stochastic Bayesian optimization for blackbox optimization
59. Effects of an Automated Diagnostic Algorithm on Human Trust
60. Assessing the robustness of accounting data for carbon neutrality plan
61. Exploring and criticizing possible transition pathways to achieve carbon neutrality
62. Reliability of petroleum emission factors towards carboneutrality
63. Sustainability risks around strategical metals for the energy transition

MECHANICAL ENGINEERING

64. Compliance measurement of machine tools
65. Error motion of rotary axes
66. Design and fabrication of multistable, origami-inspired structures
67. Optimizing the functionality of soft robots through mechanical instabilities
68. Experimental Investigation of Foam Growth Dynamics
69. Modeling the Transport of Sediments in Rivers using the Lattice Boltzmann Method
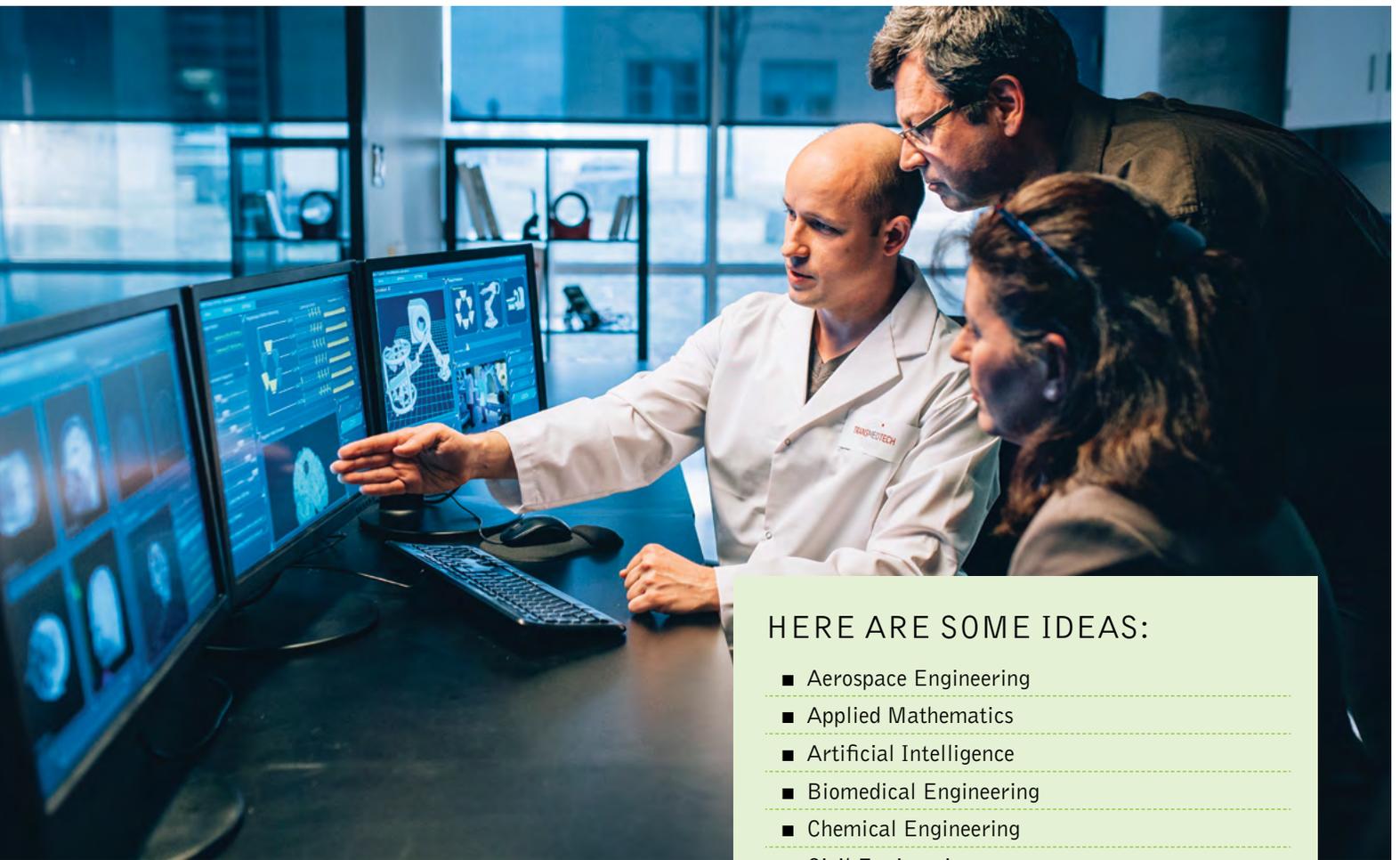
ADDITIONAL AREAS OF EXPERTISE

YOU DIDN'T FIND WHAT YOU WERE LOOKING FOR?

- Browse our professors' directory by area of expertise: ***www.polymtl.ca/recherche/rc/en/expertises***
- Submit the area of expertise you would like to work on and provide the names of 2-3 professors working in this field.
- Explain in your letter of motivation why you would like to do a research internship in this area.
- Polytechnique Montréal International will try to find the appropriate match for you!

HERE ARE SOME IDEAS:

- Aerospace Engineering
- Applied Mathematics
- Artificial Intelligence
- Biomedical Engineering
- Chemical Engineering
- Civil Engineering
- Computer and Software Engineering
- Design and Manufacturing
- Electric and Electronic Engineering
- Environmental Engineering
- Fluid Mechanics
- Fuel and Energy Technology
- Hydrology
- Industrial Engineering
- Information Technology
- Materials Science and Technology
- Mechanical Engineering
- Mining and Mineral Processing
- Nuclear Engineering
- Physics Engineering
- Robotics
- Structural Engineering

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☑ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☑ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Machine-Learning Accelerated Structural Optimization
University Cycle :	☐ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Topology Optimization (TO) of mechanical structure is a numerical tool that aims to optimize the material distribution inside a given volume with the objective to maximize the mechanical properties while minimizing the mass. Current TO methods are expensive in terms of computational and engineering time, which limits their widespread use. To support the engineers during the design phase, a new TO tool based on advanced artificial intelligence concepts will be designed to reduce the time required to generate preliminary concepts. This tool will make use of recent breakthroughs in the field of deep reinforcement learning and supervised learning.
Tasks during the Internship: *(max. 50 words)*	Interns will be involved in the exploration and implementation of AI-based structural optimization systems. A full training-test infrastructure will be built and publication of the research results is possible.
Required Skills for the Internship: *(max. 50 words)*	Candidates must be familiar with the programming language Python. Basic knowledge of popular deep learning and reinforcement learning framework is preferred. Ability to learn new tools autonomously. Good attention to detail and critical thinking skills.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Sofiane Achiche Title: Full Professor Department: Mechanical Engineering Website: https://www.polymtl.ca/expertises/en/achiche-sofiane

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2023 Summer Research Internship Program

Main area of expertise :	☑ Aerospace	☐ Biomedical	☐ Chemical
	☐ Civil, Geological, Mining	☑ Computer/Software	☑ Electrical
	☐ Mathematics/Industrial	☐ Mechanical	☐ Physics

Research Project Title : (max. 10 words)	Improving an open source flight controller firmware for autonomous drones

University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)

Background Information: (max. 100 words)	Mistlab is the creator of CogniFly: a unique open source collision autonomous quadcopter that is capable of flying autonomously. Cognifly uses a flight controller that is based on the open source Navigation-enabled flight control software INAV. INAV was developed by hobbists and, therefore, it lacks some features that would be useful for robots used in academic research. We want to add some features that will make INAV work better with Motion Capture (MOCAP), Simultaneos Localization and Mapping (SLAM) and Visual Inertial Odometry (VIO) systems. https://github.com/thecognifly

Tasks during the Internship: (max. 50 words)	Deep dive into INAV and/or INAV-Configurator to better document, fix bugs and implement the features our lab needs.

Required Skills for the Internship: (max. 50 words)	For the flight controller firmware, you must love programming in C (or at least C++). INAV-Configurator is based on Javascript, so there's an opportunity where you don't need to program in C. Ideally you should like drones (quadcopters) or at least be interested in learn more about them. Knowledge of Git / Github / Gitlab is a plus.

Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No

Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so

Supervisor:	Name: Giovanni Beltrame Title: Professor Department: GIGL Website: https://mistlab.ca

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PROJECT DESCRIPTION
2023 Summer Research Internship Scholarship Program

Area of Expertise :	☑ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☑ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Multi-Robot Planetary Exploration System
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	The aim of this project is to develop the software infrastructure needed for one (or more) human(s) and a swarm of robots to collaborate in the exploration of hardly accessible planetary environments. We are currently working with NASA and ESA to develop a multi-robot mission to explore a lava tube on the moon. As the robots advance, they shall map the environment, place themselves so that network connectivity is guaranteed, and relay data. The overall goal is to increase the performance as well as the safety of the humans involved in the exploration.
Tasks during the Internship: *(max. 50 words)*	Help in the preparation of a field mission for the exploration of a lava tube on the island of Lanzarote: write code, perform experiment with rovers and flying robots.
Required Skills for the Internship: *(max. 50 words)*	Python and/or C/C++ skills are preferable. If you are new to programming, don't worry you can learn to code with robots at MIST lab.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Others, please specify: 　　　　Name: 　　　　Address:
Supervisor:	Name:　　Giovanni Beltrame Title:　　Professor Department:　Computer and Software Engineering Website:　　https://mistlab.ca

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☑ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☑ Biomedical ☑ Computer/Software ☑ Mechanical	☐ Chemical ☑ Electrical ☑ Physics
Research Project Title : *(max. 10 words)*	3D printing sensors on heart models		
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)		
Background Information: *(max. 100 words)*	Additive manufacturing (AM) can play a crucial role in embedding novel sensing and actuation functionalities into structural components. This work utilises creating complex shaped structural models of human heart using AM. Then it uses the technology to integrate sensors developed in our lab to print integrated sensors into these complex shaped models.		
Tasks during the Internship: *(max. 50 words)*	- 3D print a heart model using FFF or SLA - Investigate suitable location for placement of sensor in artificial 3D printed heart (Lit review) - Print artificial heart with integrated sensor and study sensor response		
Required Skills for the Internship: *(max. 50 words)*	Enthusiastic towards creating things. Have hands-on experience. Be independently driven. Be well versed with design softwares like CATIA and AutoCAD. Have experience with data acquisition and data analysis using MATLAB/ Python.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Sampada Bodkhe Title: Assistant Professor Department: Mechanical Engineering Website: http://lsi.polymtl.ca/		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☑ Aerospace	☑ Biomedical	☑ Chemical
	☑ Civil, Geological, Mining	☑ Computer/Software	☑ Electrical
	☑ Mathematics/Industrial	☑ Mechanical	☑ Physics
Research Project Title : *(max. 10 words)*	Design and build a simple Voltage-to-Current Converter		
University Cycle :	☑ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☐ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Additive manufacturing (AM) can play a crucial role in embedding novel sensing and actuation functionalities by adding smart materials into structural components, thereby creating lightweight intelligent structures. But today smart materials that can be additively manufactured are limited to a few operational cycles and exhibit low strength and stiffness, hence restricting their standalone use in critical applications. This challenge can be addressed by merging the AM of active functional elements during the fabrication of intelligent structures. This project involves developing electronics to better use the smart materials in actuating applications.		
Tasks during the Internship: *(max. 50 words)*	Design a circuit that sources a low voltage signal and amplifies it to high current signal output. Optimize design for signal noise reduction. Ensure that there is proper cooling system for the electronic components. Integrate with low resistive load (0.2 Ohms) to meet power delivery requirements.		
Required Skills for the Internship: *(max. 50 words)*	Be enthusiastic towards creating things. Have hands-on experience. Be independently driven. Be well versed with design softwares like CATIA and AutoCAD. Have experience with programming micro-controllers, stepper motors. Have experience with 3D printing and programming languages like Python, MATLAB.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Sampada Bodkhe Title: Assistant Professor Department: Mechanical Engineering Website: http://lsi.polymtl.ca/		

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Main area of expertise :	☑ Aerospace	☑ Biomedical	☑ Chemical
	☐ Civil, Geological, Mining	☑ Computer/Software	☑ Electrical
	☑ Mathematics/Industrial	☑ Mechanical	☑ Physics
Research Project Title : (max. 10 words)	Machine learning to study heart behavior patterns		
University Cycle :	☑ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☐ 3rd cycle (Ph.D.)
Background Information: (max. 100 words)	Intelligent structures, those that adapt to changes in their surroundings are essential in creating reconfigurable, adaptive, and responsive structures. Additive manufacturing (AM) can play a crucial role in embedding novel sensing and actuation functionalities by adding smart materials into structural components, thereby creating lightweight intelligent structures. This project focuses on studying various heart beat patterns from the data acquired through sensors in wearables to determine various states of human motion.		
Tasks during the Internship: (max. 50 words)	Investigate suitable ML Algorithms for heart health prediction (lit review). Write suitable code for analysis of Heart Rate and Blood Pressure Data for disease detection. Design a mobile app for alerting the doctors if any abnormality is detected. Implement the ML Algorithm using the mobile app.		
Required Skills for the Internship: (max. 50 words)	Be enthusiastic towards creating things. Have hands-on experience. Be independently driven. Have experience with 3D printing and programming languages like Python, MATLAB is required.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
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Main area of expertise :	☑ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☑ Biomedical ☑ Computer/Software ☑ Mechanical	☑ Chemical ☑ Electrical ☑ Physics
Research Project Title : *(max. 10 words)*	Optimisation of 3D printed piezoelectric sensors		
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)		
Background Information: *(max. 100 words)*	Additive manufacturing (AM) can play a crucial role in embedding novel sensing and actuation functionalities by adding smart materials into structural components, thereby creating lightweight intelligent structures. But today smart materials that can be additively manufactured are limited to a few operational cycles and exhibit low strength and stiffness, hence restricting their standalone use in critical applications. This challenge can be addressed by merging the AM of active functional elements during the fabrication of intelligent structures. This project focuses on designing a network of 3D printed sensors to optimize the structural health monitoring of a structure.		
Tasks during the Internship: *(max. 50 words)*	- Suggesting designs for fully 3D printed sensors (lit review + CAD modelling). - Optimising the thickness of the sensor. - Studing the sensor's electrical response before and after integration into structures. - Developing codes to analyse the sensor data.		
Required Skills for the Internship: *(max. 50 words)*	Be enthusiastic towards creating things. Have hands-on experience. Be independently driven. Be well versed with design softwares like CATIA and AutoCAD. Have experience with 3D printing and programming languages like Python, MATLAB is recommended.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Sampada Bodkhe Title: Assistant Professor Department: Mechanical Engineering Website: http://lsi.polymtl.ca/		

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Main area of expertise :	☑ Aerospace ☐ Civil, Geological, Mining ☑ Mathematics/Industrial	☐ Biomedical ☑ Computer/Software ☑ Mechanical	☐ Chemical ☐ Electrical ☑ Physics
Research Project Title : *(max. 10 words)*	Digital twin for hydroelectric generating unit		
University Cycle :	☑ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	We are developing the Digital Twin of a hydro unit, which will combine live sensor data with physics-based modeling through artificial intelligence to achieve real-time simulation. It will allow predicting failures, optimizing maintenance schedules, and simulate scenarios of usage and wear of the equipment. To this end, we are using Physics-Informed Neural Networks and Proper Generalized Decomposition to develop reduced-order models of academic model systems exhibiting some of the same physics as hydro units. At the same time, we are designing, building and instrumenting experimental setups to validate the models.		
Tasks during the Internship: *(max. 50 words)*	You will join a team to work on the modeling or the experimental side of the project according to your strength and interests. Your tasks will vary between deriving equations, coding models, training neural networks, running simulations or designing, sizing, manufacturing, assembling and testing an experimental setup.		
Required Skills for the Internship: *(max. 50 words)*	Skills are optional, motivation and will to learn are mandatory! Modeling: coding (python, matlab, C), vibration and dynamics, finite element analysis, neural networks, reduced order modeling. Experimenting: CAD (Catia, Solidworks), designing, machining, intrumentation.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Frederick Gosselin Title: Professor Department: Mechanical Engineering Website: www.fgosselin.com		

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Main area of expertise :	☑ Aerospace ☐ Biomedical ☐ Chemical ☑ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☑ Mathematics/Industrial ☑ Mechanical ☑ Physics
Research Project Title : *(max. 10 words)*	Drag reduction by elastic reconfiguration of a flat plate in a wind tunnel
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Plants rely on their flexibility to change form and reduce their drag when subjected to fluid flow. Flexibility allows plants to reduce their drag through reconfiguration, however it is well known that flexibility can also lead to a loss of stability and thus increased dynamical loads. Fluttering flags are a good example. In the proposed project, we will consider the limitation to reconfiguration brought by a dynamic loss of stability in constant uniform flow. To understand the trade-off that flexibility brings to real plants in terms of drag reduction and loss of stability, we will study an idealised system: a thin flat plate clamped at its centre and subjected to a normal flow in a wind tunnel.
Tasks during the Internship: *(max. 50 words)*	You will join a team to work on the modeling or the experimental side of the project according to your strength and interests. Your tasks will vary between deriving equations, coding models, running simulations or designing, sizing, manufacturing, assembling and testing an experimental setup and performing wind tunnel tests.
Required Skills for the Internship: *(max. 50 words)*	Skills are optional, motivation and will to learn are mandatory! Modeling: coding (python, matlab, C), fluid mechanics, vibration and dynamics, finite element analysis, computational fluid dynamics. Experimenting: CAD (Catia, Solidworks), designing, machining, intrumentation.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
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Main area of expertise :	☑ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☑ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Improvements to an LBM multicomponent MATLAB code for fluid dynamics
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	The Lattice Boltzmann Method (LBM) is a rapidly growing approach for the simulation of fluid dynamics. The project aims to simulate the impact of a water droplet on a surface using the LBM. Polytechnique LBM research group is very active in the development of LBM for multiphase/multicomponent flows. Various contributions by Sébastien Leclaire were proposed for the Rothman-Keller (RK) color model and Sami Ammar proposed improvements to the Shan-Chen (SC) approach to study higher Reynolds numbers. The current project aims to implement recent modifications from literature to the RK method allowing higher density ratios (water-air) and higher Reynolds numbers.
Tasks during the Internship: *(max. 50 words)*	The objective is to modify an existing code based on the RK approach to implement modifications proposed in literature to increase density ratios and Reynolds numbers: Understand the LBM, the existing code and the modifications proposed; Implement the modifications in MATLAB; Verify and validate the new code.
Required Skills for the Internship: *(max. 50 words)*	The project requires analytical, numerical and programming skills. 1. Good mathematical background. 2. Fluid mechanics knowledge 3. Basis in numerical methods. 4. Ability to program in MATLAB 5. Good debugging abilities.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Sébastien Leclaire Title: Professor Department: Mechanical Engineering Website: https://www.polymtl.ca/expertises/leclaire-sebastien

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☑ Aerospace	☐ Biomedical	☐ Chemical
	☐ Civil, Geological, Mining	☐ Computer/Software	☐ Electrical
	☐ Mathematics/Industrial	☑ Mechanical	☐ Physics
Research Project Title : *(max. 10 words)*	Additive manufacturing (3D printing) of composites and multifunctional devices		
University Cycle :	☑ 1st cycle (Undergraduate) ☐ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)		
Background Information: *(max. 100 words)*	Additive manufacturing (AM) or 3D printing refers to a family of processes of joining materials in order to fabricate objects layer by layer from a computer-aided-design (CAD) model. Our team at the Laboratory of multi-scale mechanics (LM2) develops new materials and printing processes mainly for aerospace applications. For this internship project, the intern will help a masters student to develop a new printing platform for non-planar fused filament fabrication (FFF) printing of continuous carbon fiber thermoplastic composites followed by characterization of printed parts (e.g., mechanical performance, microscopy observation).		
Tasks during the Internship: *(max. 50 words)*	The intern will work in collaboration with other graduate students from the research group. His/her tasks will be to assist the senior students with some of their experiments and data analysis (e.g., material characterization, tailoring of printing parameters, mechanical tests). He/she will participate in meetings.		
Required Skills for the Internship: *(max. 50 words)*	Background in Mechanical, Mechatronics, or Materials science (polymers, composites, nanocomposites), CAD (e.g., CATIA v. 5), Experimental material characterization (e.g., microscopy, mechanical testing), Programming skills (e.g., LabView, Python).		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Daniel Therriault Title: Professor Department: Mechanical Engineering Website: https://www.polymtl.ca/lm2/		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	An Impact Rig for Replicating Fall Conditions in Elderly
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	In North America, more than 330,000 seniors per year suffer a hip fracture, the most common injury in this population. In fact, one-third will suffer a fall and the impact of these falls accounts for more than 95% of fractures. Once a hip fracture occurs, 20% die within a year. Azimut Medical aims to prevent hip fractures with an intelligent wearable garment that detects a fall before impact and deploys an airbag. To assess the reduction of the impact force, Azimut aims to design an impact rig to replicate multiple fall conditions in elderly. Current impact rigs only replicate lateral impacts.
Tasks during the Internship: *(max. 50 words)*	The intern will be involved in the design, material selection (mechanical, electrical & hip replication components) and result extraction of the impact rig. Publications of this research project is possible.
Required Skills for the Internship: *(max. 50 words)*	The candidate must be familiar with the Arduino IDE and C or equivalent programming languages, with basic electronic components such as ADC, Op-Amp, microcontrollers and with CAD softwares such as CATIA, Fusion 360 or equivalent. The candidate must be curious, autonomous, have grit and creativity.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: Azimut Médical's Office Space ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Sofiane Achiche Title: Full Professor Department: Mechanical Engineering Website: https://www.polymtl.ca/expertises/en/achiche-sofiane

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☑ Biomedical ☑ Computer/Software ☑ Mechanical	☐ Chemical ☐ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	Gaze Estimation-Based Assistive Robotic Arm Interface		
University Cycle :	☐ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Assistive robotic arms (ARA) are generally mounted on motorized wheelchairs of people suffering from upper-limb disabilities such as muscular dystrophia or cerebral paralysis. A point of gaze estimation-based control method has been developed which allows for automatic movements and grasping actions of ARAs with obstacle avoidance and graspable object recognition. Although clinical trials are currently on-going, the system still requires further improvements and the addition of new features for it to be made available.		
Tasks during the Internship: *(max. 50 words)*	Examples: Development of additional control interfaces for the current system based on facial features; further development in the path and motion planning modules for faster performance and lower collision rate; implementation, training and validation of new or improved deep learning gaze estimation models.		
Required Skills for the Internship: *(max. 50 words)*	- Strong programming skills in Python, with possible C++ interfacing. - Knowledge of and familiarity with computer vision and 3D processing algorithms. - Knowledge of or willingness to learn on Robotics. - Optional: PyTorch, including training, validation and prototype deployment.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Sofiane Achiche Title: Full Professor Department: Mechanical Engineering Website: https://www.polymtl.ca/expertises/en/achiche-sofiane		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☑ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : (max. 10 words)	Intelligent conversational agent to support people with chronic conditions: MARVIN
University Cycle :	☐ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: (max. 100 words)	Mobile health offers promising solutions for empowering users and giving patients greater over their health management. Chatbots have proven to be an acceptable medium for the general public. They typically act as virtual assistants that talk to users, harnessing the power of AI to enable natural language interpretation as well as help with decision-making. In collaboration with McGill University Health Centre, my research team has developed the first version of a chatbot called MARVIN. This project will seek to further develop a chatbot-based personalized healthcare tool that uses state-of-the-art technologies to make MARVIN a truly constant telehealth companion.
Tasks during the Internship: (max. 50 words)	Existing healthcare chatbots lack continuity and interactivity. This limits the motivation for long-term use and consequently leads to a decrease in user adherence. The mandate will be to optimize MARVIN's current model to enable it to conduct conversations in a proactive and user-friendly manner.
Required Skills for the Internship: (max. 50 words)	Experience in computer programming and artificial intelligence. Knowledge of Natural Language Processing (NLP) would be an asset. Attention to detail and critical thinking skills. Team player with good communication skills. Fluency in English and/or French, bilingualism is an asset.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Sofiane Achiche Title: Full Professor Department: Mechanical Engineering Website: https://www.polymtl.ca/expertises/en/achiche-sofiane

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☑ Biomedical ☑ Computer/Software ☑ Mechanical	☐ Chemical ☑ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	Unsupervised Machine Learning for Abnormal Movement Detection in Elderly		
University Cycle :	☐ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)		
Background Information: *(max. 100 words)*	In North America, more than 330,000 seniors per year suffer a hip fracture, the most common injury in this population. In fact, one-third will suffer a fall and the impact of these falls accounts for more than 95% of fractures. Once a hip fracture occurs, 20% die within a year. Azimut Medical aims to prevent hip fractures with an intelligent wearable garment that detects a fall before impact and deploys an airbag. In the value proposition, Azimut aims to detect movements that are abnormal in the elderly population in order to detect "potential" fall occurrences and alert helpers.		
Tasks during the Internship: *(max. 50 words)*	Candidates will be involved in the exploration and implementation of an unsupervised machine learning algorithm for abnormal movement detection in elderly. The dataset, composed of IMU signals, will be made available by Azimut Medical. Publications of this research project's result is possible.		
Required Skills for the Internship: *(max. 50 words)*	Candidates must be familiar with the programming language Python. Intermediate knowledge of popular machine learning framework is preferred. The candidate must be curious, autonomous, have grit and creativity.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: Azimut Médical's Office Space ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Sofiane Achiche Title: Full Professor Department: Mechanical Engineering Website: https://www.polymtl.ca/expertises/en/achiche-sofiane		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Biomedical ☑ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : (max. 10 words)	Co-axial non toxic collagen/PCL electrospinning
	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)
Background Information: (max. 100 words)	Electrospinning is a process used to produce micro- to nano- scale fibers. Co-axial electrospinning allows to produce fibers with a core/shell structure made from 2 different materials. Natural and synthetic polymers have properties which complement each other: where synthetic polymers offer strong and sustained mechanical over time but lack biocompatibility, natural polymers encourage cell adhesion but degrade quickly. A combination of a natural polymer (collagen) as outer layer and synthetic polymer (PCL) as inner shell would be most beneficial for tissue engineering applications.
Tasks during the Internship: (max. 50 words)	Optimizing electrospinning parameters on a given device, using non toxic solvents (water/ethanol) and a heating device.
(max. 50 words)	- Polymer chemistry and processing - Chemical lab skills
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
	Name: Abdellah Ajji Title: Professor Department: Chemical Engineering https://www.polymtl.ca/expertises/en/ajji-abdellah

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☑ Biomedical ☐ Computer/Software ☐ Mechanical	☐ Chemical ☐ Electrical ☑ Physics
Research Project Title : *(max. 10 words)*	Blood-based brain cancer recurrence detection using optical spectroscopy		
University Cycle :	☑ 1st cycle (Undergraduate) ☐ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)		
Background Information: *(max. 100 words)*	Many diagnostic tests for disease presence, progression and severity are invasive, expensive, time-consuming or lack sensitivity/specificity. Meanwhile, there is a lack of biofluid-based assessment for many cancers, as well as for infectious diseases. The goal of this project is to develop a point-of-care biofluid system relying on Raman spectroscopy coupled with machine learning, microfluidics and plasmonic technology. The platform will allow for rapid diagnostic test development using label-free and/or ligand-based Raman spectroscopy, to rapidly provide a reading at the time of sample acquisition, with the potential to detect multiple diseases from the same biospecimen.		
Tasks during the Internship: *(max. 50 words)*	Development of a test allowing to assess post-surgery brain cancer disease recurrences. Tasks will be related to assembling large datasets of biofluid samples, developing machine learning predictive techniques and fabricate nanostructured surfaces allowing signal enhancement and reduction of imaging times.		
Required Skills for the Internship: *(max. 50 words)*	- Programming - Experimental techniques in biomedical sciences - Basic knowledge in optics - Signal processing		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Frédéric Leblond Title: Full Professor Department: Engineering Physics Department Website: https://lroinnovation.com		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☑ Biomedical ☐ Computer/Software ☐ Mechanical	☐ Chemical ☐ Electrical ☑ Physics
Research Project Title : *(max. 10 words)*	Tumor detection using depth-resolved biomolecular spectroscopy imaging		
University Cycle :	☑ 1st cycle (Undergraduate) ☐ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)		
Background Information: *(max. 100 words)*	Clinical translation of Raman spectroscopy systems for use as an aid for surgical guidance presents challenges. Importantly, current technologies only provide superficial tissue information, limiting breast cancer margins assessment and leading to cancer recurrences and the need for a second surgery. This project aims to develop a margin assessment technique relying on new a dual surface/subsurface imaging technique that will be validated during breast-conserving surgery procedures. This will be done using a large-field line-scanning system to ensure that the surface of the specimen is free of cancer, and that there is no cancer up to 2 mm depth from the surface.		
Tasks during the Internship: *(max. 50 words)*	Development and validation of the depth-resolved Raman spectroscopy technique relying on the principle of spatial-offset imaging. An experimental protocol will be executed to assess imaging performances in tissue phantoms. The ability of the system to detect invasive breast cancer will then be assessed.		
Required Skills for the Internship: *(max. 50 words)*	- Programming - Experimental techniques in biomedical sciences - Basic knowledge in optics - Signal processing		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Frédéric Leblond Title: Full Professor Department: Engineering Physics Department Website: https://lroinnovation.com		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Design of an orthopedic brace for adolescent idiopathic scoliosis with tunable stiffness
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Orthopedic braces are used to correct mild to moderate spinal deformities. They are typically made of stiff materials, custom-fit around the child's torso to apply the necessary pressure to straighten the spine and prevent further deformity until the skeletal maturity. While the brace has to be worn almost all the time to be effective, there might be periods of time (e.g., while sitting down, exercising, etc.) where temporary flexibility could enhance comfort. The objective of the project is to design a brace that can easily switch between a stiff, spine-straigthening mode to a flexible, comfortable mode. This research will be conducted in collaboration with an interdisciplinary team from the CHU Sainte-Justine.
Tasks during the Internship: *(max. 50 words)*	1- Establishment of technical specifications; 2- Exploration of engineering materials with tunable stiffness (e.g., multistable architected materials, origami-inspired structures, jamming structures); 3- Design of the orthosis incl. an actuation mechanism to switch between 2 modes; 4- Manufacturing (3D printing) and testing.
Required Skills for the Internship: *(max. 50 words)*	To conduct this research project, the ideal student should be creative, self-driven, familiar with computer aided design, programming, the finite elements method, and prototyping via 3D-printing.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: CHU Sainte-Justine ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: 1.David Mélançon 2.Carl-Éric Aubin Title: 1.Assistant Professor 2.Full Professor & CEO TransMedTech Department: 1&2.Mechanical Engineering Website: 1.https://dmelancon.com 2.https://transmedtech.org/

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Biomedical ☑ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	3D electrochemical biosensor for the detection of bacteria in Prosthetic Joint Infection
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Prosthetic joint infections (PJI) are a leading cause of failure and reoperation following joint replacement surgery. The identification of the causative bacteria is critical for selecting the most appropriate surgical treatment and antibiotic therapy. Given that surgeons will prefer to apply a technique that they are familiar with, we will design a surgical pencil that can be attached to a handheld device, that communicates to an external diagnostic computer system via a wireless interface. Exploring the modification of surgical tools into intelligent surface-modified electrodes, infection markers will be specifically and selectively detected directly in the joint.
Tasks during the Internship: *(max. 50 words)*	Immobilisation of peptide on electrode surface (microelectrode) ; Study the effect of length of peptide versus performance of the electrode (accuracy, sensitivity, specificity, stability and reproducibility).
Required Skills for the Internship: *(max. 50 words)*	- Knowledge of electrochemistry basis - Pippeting - Excel
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Geraldine Merle Title: Associate Professor Department: Biomedical engineering Website: https://www.polymtl.ca/expertises/en/merle-geraldine

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Biomedical ☑ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Adhesive surfaces for soft tissue binding
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Binding organic tissue is a difficult task in biological repair, as tissue is dynamic and wet. Where sutures bind two soft tissues in 1 dimension, and bone cement bridges static defects, creating a perfect adhesion of two soft tissue surfaces is challenging. The current tissue adhesives are cytotoxic, not compatible with wet and/or organic surfaces and rigidify to bear the applied loading: they are not suited for dynamic tissue movement. However, a new tough adhesive inspired by slug defensive mucus has been developed, using alginate (Alg) and polyacrylamide (PAAm).
Tasks during the Internship: *(max. 50 words)*	To use existing literature resources and adapt this technology to an existing projet: binding a synthetic ACL scaffold with a biological ACL.
Required Skills for the Internship: *(max. 50 words)*	Chemistry knowledge, rigor, autonomy, research curiosity.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Géraldine Merle Title: Associate Professor Department: Chemical engineering Website: https://sites.google.com/view/geraldinemerlelab/home?pli=1

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Biomedical ☐ Chemical
	☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical
	☐ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : (max. 10 words)	Calcium Expression of Cells from Fractured Mice Femurs following Cold-Therapy
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)
Background Information: (max. 100 words)	Calcium is an essential part of the mineralization process that leads to formation of a bony callus (mineralized) from a soft callus (not mineralized) involving osteoblasts (OBs) and osteocalcin (OCN). This project will look into the effect of cold-therapy on OBs and OCN and whether cold related application has a significant effect on OBs and calcium related pathways in fracture repair.
Tasks during the Internship: (max. 50 words)	Cell Culture Maintenance, counting viable cells, data analysis, literature review
(max. 50 words)	In vitro technique, cell culture lab skills, histological staining.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No
	Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☐ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt)
	☑ Other, please specify: Montreal General Hospital
	☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Geraldine Merle
	Title: Associate Professor
	Department: Chemical Engineering
	Website: https://www.polymtl.ca/expertises/en/merle-geraldine

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☑ Biomedical ☐ Computer/Software ☐ Mechanical	☐ Chemical ☐ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	Synergistic Properties of Parathyroid Hormone & Cold-Therapy on Calcium Pathways			
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)			
	Intermittent administration of parathyroid hormone produces anabolism in osteoporotic skeleton.Therapy is based on the alteration of systemic and local factors promoting os-teoblast activity before its stimulation of osteoclast activity catches up, creating an "ana-bolic window" to restore bone mass and structure. PTH has been shown to promote chondrogenesis in fracture repair, but can lead to hypercalcemia. Solutions to enhance the actions of PTH without producing hypercalcemia is vital. Calcimimetics are non-ionic allosteric CaSR agonists, used clinically to treat hyperparathyroidism and hyper-calcemia by activating the CaSR. Given activiation of CasR by cold, this project is to as-sess the synergistic effect of cold with PTH.			
	Histoimmunological staining and tissue processing (embedding, sectionning), data analysis, assist PhD student with in vivo experiments			
	Basic chemical lab skills, microscopy, tissue processing, statistical experience.			
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No			
Location:	☐ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: Montreal General Hospital ☐ This project can be offered remotely if the sanitary situation requires so			
Supervisor:	Name: Geraldine Merle Title: Associate Professor Department: Chemical Engineering Website: https://www.polymtl.ca/expertises/en/merle-geraldine			

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☑ Biomedical ☑ Computer/Software ☑ Mechanical	☐ Chemical ☑ Electrical ☑ Physics
Research Project Title : *(max. 10 words)*	Design and prototyping of a semi-active ankle exoskeleton		
University Cycle :	☐ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	The rehabilitation procedure for a wide range of patients with neuromotor impairments requires customization of exercise intensity. In recent years, exoskeletons have been used to help patients in their rehabilitation programs. They are usually motorized (active) to induce additional forces and movements to assist users or to change the intensity of walking exercises. The primary application of this device will be focused on rehabilitation procedures. However, this device can be used for the assistance of the elderly and patients with neuromuscular disorders, as well as for sports and recreational purposes.		
Tasks during the Internship: *(max. 50 words)*	- Develop a semi-active exoskeleton whose joint is not motorized, but its impedance is controlled by a motorized spring. - Develop a spring with variable stiffness using an electric motor and their editor. - Prototype an ankle exoskeleton using 3D printers.		
Required Skills for the Internship: *(max. 50 words)*	- Expertise in Mechanisms design and mechanical components. - Expertise with 3D modeling - Knowledge in prototyping with 3D printers		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Abolfazl Mohebbi Title: Professor Department: Mechanical Engineering Website: www.polarlab.ca		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☑ Biomedical ☑ Computer/Software ☑ Mechanical	☐ Chemical ☑ Electrical ☑ Physics
Research Project Title : *(max. 10 words)*	Design of a control system for a pediatric exoskeleton robot		
University Cycle :	☐ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Polytechnique lab for assistive and rehabilitation technologies (POLAR) is working on designing a lower-limb exoskeleton robot for pediatric cerebral palsy patients. To incorporate this robot into rehabilitation programs and everyday assistance scenarios, proper impedance-based control systems as well as position/torque servo control systems should be designed and embedded into an on-board processing unit. This control system will regulate the physical interactions between the user and the exoskeleton. The on-board system will be also used to communicate data with the user interface of a software/mobile application to monitor the activity of the patient and their progress.		
Tasks during the Internship: *(max. 50 words)*	Literature study of the interactive control models for exoskeleton robots Modeling position/torque and impedance control systems using MATLAB/Simulink Implementation of the control model into a real-time system Validation tests.		
Required Skills for the Internship: *(max. 50 words)*	- Programming with MATLAB/SIMULINK and C++ (basic knowledge is required) - Knowledge in Control Systems Design - Experience with embedded processors (Arduino, Raspberry PI, etc)		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Abolfazl Mohebbi Title: Professor Department: Mechanical Engineering Website: www.polarlab.ca		

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Main area of expertise :	☐ Aerospace ☑ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☑ Physics
Research Project Title : *(max. 10 words)*	Development of Robotic Force/Torque Sensor
University Cycle :	☐ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	A force torque (FT) sensor is an electronic device that is designed to monitor, detect, record and regulate linear and rotational forces exerted upon it. In other words, the FT sensor in a robotic or mechanical system can be compared to the micro-receptors in skin that equip animals with the sense of "touch." At the Polytechnique lab for Assistive and Rehabilitation technologies (POLAR), we want to focus on developing a FT sensor for safe human-robot interaction during assistance and rehabilitation tasks. For more information, please refer to the article below: https://link.springer.com/content/pdf/10.1007/978-94-007-7194-9_104-1.pdf
Tasks during the Internship: *(max. 50 words)*	1- Design a Force/Torque sensors unit with electrical components available on the market. 2- Design and prototype a housing (enclosure) for the sensing unit 3- Create an Application Programming Interface (API) to use the FT sensor with the robot control system.
Required Skills for the Internship: *(max. 50 words)*	1- Electronics & micro-controllers/embedded systems (e.g. Arduino, Rsapberry Pi, ..) 2- Familiarity with manipulator robot mechanics (kinematics and dynamics) 3- Programming with C++ and Python
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
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Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☑ Biomedical ☑ Computer/Software ☑ Mechanical	☐ Chemical ☑ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	Modeling, Simulation and Analysis of a gait exoskeleton in the Float system		
University Cycle :	☑ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	For millions of children with neuromuscular disorders, debilitating weakness makes everyday tasks nearly impossible, such as gait. And no satisfying commercial exoskeleton has ever existed for them. But with the emerging innovative 3D-printed exoskeletons, the impossible becomes possible. We have developed an innovative gravity-balancing actuated exoskeleton, available to children who need it, thanks to 3D-printing. The objective of this project is to model and simulate the dynamics of this innovative exoskeleton of the lower limb, based on our expertise and infrastructure on multibody modeling, and measurements from the motion analysis system Float (https://reha-stim.com/fr/the-float/).		
Tasks during the Internship: *(max. 50 words)*	Get familiarized with multibody dynamics (www.edx.org/course/ modeling-and-simulation-of-multibody-systems-part-i) and with our motion capture systems including the FLOAT, following our training plan; perform measurements and multibody modeling; Technical Report, user's guide, and transfer.		
Required Skills for the Internship: *(max. 50 words)*	- Knowledge in mechanics / kinematics and dynamics. - Ability to focus to follow training plans with devices. - Taste for multidisciplinary project in an engineering team in a clinical environment.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No		
Location:	☐ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: Technopole in pediatric rehabilitation ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Maxime Raison Title: Full professor Department: Mechanical engineering Website: https://www.polymtl.ca/recap/en/		

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2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☑ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Real-time Quantification of Muscle Forces
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	The major problem to assess individual muscle forces is to solve the muscle force redundancy problem, as several muscles overactuate each human body joint. To solve this problem, a novel non-invasive method was proposed by the lab by using musculoskeletal modeling and data from electromyograpy (EMG) and inertial motion units (IMU). The objective is to contribute to the development of a novel tool for real-time quantification of muscle forces based on musculoskeletal modeling and electromyography, by either extending the musculoskeletal model or transforming the process in real-time, or both.
Tasks during the Internship: *(max. 50 words)*	Get familiarized with our musculoskeletal modeling in MATLAB and Python; Contribute to the development of a novel tool for real-time quantification of muscle forces based on musculoskeletal (probably in Python); Extend the musculoskeletal modeling; Technical Report, user's guide, and transfer.
Required Skills for the Internship: *(max. 50 words)*	- Basic knowledge of coding in MATLAB and Python, but C++ is a plus; - Basic knowledge about musculoskeletal modeling (biomechanics); - Knowledge of filtering and optimization is a must; - Taste for multidisciplinary project in an engineering team in a clinical environment.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No
Location:	☐ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: Technopole in pediatric rehabilitation ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Maxime Raison Title: Full professor Department: Mechanical engineering Website: https://www.polymtl.ca/recap/en/

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Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☑ Biomedical ☑ Computer/Software ☑ Mechanical	☐ Chemical ☑ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	Re-design of a Robotic Arm To Assist Patients with Musculoskeletal Disorders		
University Cycle :	☑ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Robotics arms assisting patients with musculoskeletal disorders, such as JACO(TM) developed by the Canadian company Kinova, are emerging. Our research laboratory developed a very competitive assistive robotic arm, with 3D printing and Dynamixel motors, which can be commanded by either Matlab on a computer, or Arduino when embedded. This robot can not only assist beneficiaries, but even play ping pong.		
Tasks during the Internship: *(max. 50 words)*	Adapt the robot to lower its cost: adapt the CAD files (Fusion 360) to integrate the 12A or 18A Dynamixel motor 6-packs (bulks); adapt the CAD files to integrate anti-gravitational mechanisms from already existing 3D printed mechanisms in our lab (but from other devices); assemble, test; Technical Report, user's guide, and transfer.		
Required Skills for the Internship: *(max. 50 words)*	Knowledge of coding in Fusion 360 (Autodesk); Knowledge about design; Knowledge about command; Basic knowledge about Matlab and Arduino; Knowledge of robotics processing is a must; Taste for multidisciplinary project in an engineering team in a clinical environment.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No		
Location:	☐ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: Technopole in pediatric rehabilitation ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Maxime Raison Title: Full professor Department: Mechanical engineering Website: https://www.polymtl.ca/recap/en/		

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Main area of expertise :	☐ Aerospace ☐ Biomedical ☑ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Development of numerical models to simulate granular flows
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Metal additive manufacturing (AM) is growing fast, progressively moving from prototyping and R&D to part production. Most metal AM processes use metal powder as their base feedstock and several flowability challenges remain to be solved to facilitate this transition toward high-end applications. Poor understanding of powder flowability lead to severe problems for manufacturers which can lead to failure of the printed part due to the presence of porous zones or high residual stresses. This project aims at better characterising and predicting the flow behaviour of AM powders, and improving powder flow simulation.
Tasks during the Internship: *(max. 50 words)*	- Design and carry out Discrete Element Method (DEM) simulations; - Develop in C++ without our high-performance DEM code; - Develop tools to post-process DEM simulation results.
Required Skills for the Internship: *(max. 50 words)*	- An interest in numerical simulation - Some knowledge on fluid dynamics or classical mechanics - Some Python or C++ programming experience - Basic knowledge about the Linux operating system
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Bruno Blais Title: Professor Department: Chemical Engineering Website: https://www.polymtl.ca/expertises/en/blais-bruno

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Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☐ Biomedical ☐ Computer/Software ☐ Mechanical	☑ Chemical ☐ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	Enhancing heat transfer through 3d printed lattice structure		
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)		
Background Information: *(max. 100 words)*	Metal additive manufacturing (AM) is growing fast, progressively moving from prototyping and R&D to part production. AM enables the generation of new innovative structures which include lattice structures. These structures provide lightweight filling to component and have the capacity to enhance the heat transfer, the mass transfer and the mixing in many chemical and metallurgical processes. The goal of this project is to investigate the impact of lattice infilling on the cooling efficiency of thermal extraction processes.		
Tasks during the Internship: *(max. 50 words)*	- Carry out simulation of the hydrodynamics and heat transfer using a high-performance open-source CFD code - Develop a methodology to post-process the simulation results in Python		
Required Skills for the Internship: *(max. 50 words)*	- An interest in numerical simulation - Some knowledge on fluid dynamics or classical mechanics - Some Python or C++ programming experience - Basic knowledge about the Linux operating system		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Bruno Blais Title: Professor Department: Chemical Engineering Website: https://www.polymtl.ca/expertises/en/blais-bruno		

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Main area of expertise :	☐ Aerospace ☐ Biomedical ☑ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Understanding the hydrodynamics of particle swarms through simulation
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	The flow of swarm of particles play a critical role in fluidized bed and spouted bed reactors , dryer and multiple other unit operations that are prevalent in the chemical process industry. The design of these unit operations remains a considerable challenge. This is in large part cause by the hydrodynamic interaction between the particles. Indeed, even if the macroscopic flow around the particles is uniform, the interaction between the fluid and the particle generate complex structures that greatly affect the efficiency of these process. The goal of this project is to further our understanding of these type of flows throughout direct numerical simulations (DNS) of particle-laden flows.
Tasks during the Internship: *(max. 50 words)*	- Carry out simulation of the hydrodynamics of freely moving particle using a high-performance open-source CFD code - Develop a methodology to post-process the simulation results in Python - Validate results with experiments
Required Skills for the Internship: *(max. 50 words)*	- An interest in numerical simulation - Some knowledge on fluid dynamics or classical mechanics - Some Python or C++ programming experience - Basic knowledge about the Linux operating system
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Bruno Blais Title: Professor Department: Chemical Engineering Website: https://www.polymtl.ca/expertises/en/blais-bruno

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Main area of expertise :	☐ Aerospace ☐ Biomedical ☑ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☑ Physics
Research Project Title : *(max. 10 words)*	Fabrication and characterization of printed stretchable devices
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Stretchable bioelectronics are expected to play an important role in wearable electronics. Solution-processable conducting materials are desirable because of their low cost and fast device production. In our laboratory, we are we producing t fully stretchable organic electrochemical transistors (OECTs) by printing all components of the device. In this project, the intern will participate to a research activity on all-printed transistors, which will include patterning all components of stretchable OECTs on stretchable thermoplastic polyurethane (TPU) using a printed circuit board (PCB) printer, as well as their electromechanical characterization.
Tasks during the Internship: *(max. 50 words)*	The intern will fabricate organic electrochemical transistors with conductive polymers as active channel, and then characterize the transistors.
Required Skills for the Internship: *(max. 50 words)*	Basic understanding of organic conducting materials and measuring skill for electrical devices(the transistors), fluency in English or French.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Fabio Cicoira Title: Professor Department: Chemical Engineering Website: https://www.polymtl.ca/iontronics/en

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Main area of expertise :	☐ Aerospace ☑ Biomedical ☑ Chemical ☐ Civil, Geological, Mining ☑ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☑ Physics
Research Project Title : *(max. 10 words)*	Hydrogels for epidermal electronics
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Soft, stretchable, conductive, and adhesive materials are highly desired for wearable electronics. In particular, soft, flexible, and adhesive films and gels with Young's modulus matching biological tissues (with moduli of 0.5-500 KPa) have become a research hotspot in bioelectronics due to the improved interface between biological tissues and electronics. Epidermal electronics are attracting many researchers in different fields such as human vital signs monitoring (e. g. electrocardiography (ECG), electromyography (EMG), and electroencephalography (EEG)), sweat analysis, and glucose tests. In this research, conductive polymers gels are used to fabricate epidermal electrodes which are stretchalbe, self-healble, and capable of recording ECG, EMG, and EEG signals.
Tasks during the Internship: *(max. 50 words)*	- Getting familiar with the subject by studying the related work - Participating in meetings to report progress or any potential issues - Delivering progress report end of each month - Conducting experiments and pushing one or two papers
Required Skills for the Internship: *(max. 50 words)*	- Having knowledge about conductive and electroactive polymers - Being able to do mechanical and self-healing tests (e. g. tensile strength test). - knowledge about bio-potential signals processing
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Fabio Cicoira Title: Full professor Department: Chemical Engineering Website: https://www.polymtl.ca/iontronics/en/people

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PROJECT DESCRIPTION
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Main area of expertise :	☐ Aerospace ☑ Biomedical ☑ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☑ Physics
Research Project Title : *(max. 10 words)*	Kirigami Bioelectronics
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	The main objectives of this internship is to fabricate novel electrodes based on conducting polymers, to monitor body signals, using auxetic patterns. Auxetics are structures with a negative Poisson's ratio. When stretched, they will expand instead of getting thinner like conventional materials. They have been shown to increase durability of a material. Many parts of the body are composed of negative Poisson's ratio tissues. Using conductive polymers, auxetic patterns might prove useful for durable biomedical applications. The fabrication of auxetic sensors will be completed using 3D printed molds, laser cutting and drop-casting on flexible and stretchable substrates.
Tasks during the Internship: *(max. 50 words)*	- Getting familiar with the subject by studying the related work - Participating in meetings to report progress or any potential issues - Delivering progress report end of each month - Conducting experiments and pushing one or two papers
Required Skills for the Internship: *(max. 50 words)*	- Having knowledge about conductive and electroactive polymers (asset) - Being able to do mechanical and self-healing tests (e. g. tensile strength test). - Knowledge about bio-potential signals processing - Fluency in English or French
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Fabio Cicoira Title: Professor Department: Chemical Engineering Website: https://www.polymtl.ca/iontronics/en

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Main area of expertise :	☐ Aerospace ☐ Biomedical ☑ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Neuromorphic Organic Electrochemical Transistors
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Neuromorphic systems mimicking the architecture and function of human nervous system have attracted more and more interests and shown promising potential in future computing technology. Organic electrochemical transistors (OECTs) are new developed devices whose electrical signals can be modulated through ionic participation. They have been widely utilized in bioelectronics. The memory functions of OECTs devices, including short- and long-term plasticity, have been demonstrated, to play a significant role in the neuromorphic system and artificial neural network. Here we would like to make OECTs devices through electropolymerization, a bottom-up processing technique, and explore their neuromorphic functions.
Tasks during the Internship: *(max. 50 words)*	1. Fabricating the organic electrochemical transistors (OECTs) through conducting polymer electropolymerization method. 2. Measuring the electrical performance of fabricated OECTs. 3. Measuring the neuromorphic functions of prepared OECTs
Required Skills for the Internship: *(max. 50 words)*	1. Basic knowledge on eletronic devices/organic materials. 2. Interests on organic electronic devices and their neuromorphic functions. 3. Fluency In English or French
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Fabio Cicoira Title: Full Professor Department: Chemical Engineering Website: https://www.polymtl.ca/iontronics/en

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Research Project Title : (max. 10 words)	PEDOT electrodeposition using a biocompatible polyanion
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: (max. 100 words)	Electrochemical synthesis is a common way to fabricate conducting polymers. Today, electrochemical polymerization of PEDOT is carried out with three electrodes, including working, counter, and reference electrodes in a solution of the monomer, appropriate solvent, and dopant. On the working electrode surface, monomers are oxidized to form radical cations, which react with each other to form a polymer coating on the surface of the electrode. In this project, we will investigate the effects of a biocompatible polyanion on PEDOT deposition. PEDOT will be electrodeposited using a nontoxic counter ion such as fibrinogen, carboxymethyl cellulose, and pectin for biomedical applications.
Tasks during the Internship: (max. 50 words)	The internship student is supposed to electrodeposit PEDOT using a biocompatible counter ion on metallic electrodes, and also, to investigate the effect of deposition parameters on the properties of final film.
Required Skills for the Internship: (max. 50 words)	Chemistry or chemical engineering background and being familiar with the basics of electrochemistry is required.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Fabio Cicoira Title: Professor of Chemical Engineering Department: Chemichal Engineering Department Website: https://www.polymtl.ca/iontronics/en/people

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Main area of expertise :	☐ Aerospace ☑ Biomedical ☑ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☑ Physics
Research Project Title : *(max. 10 words)*	Self-healable, stretchable and conductive polymers for wearable electronics
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	In wearable devices, various structural design approaches using polymers have been developed to improve flexibility and stretchability. However, various damages such as warping, cutting, compression, and overuse cause deterioration or breakage, resulting in reduced reliability and lifespan of electronics. Therefore, it is desirable to develop polymers capable of self-healing to restore unexpected damages and physical properties. In this study, self-healable polymers with multiple dynamic bonds will be synthesized/fabricated using structural strategies of materials, and their physical properties will be analyzed and interpreted.
Tasks during the Internship: *(max. 50 words)*	Synthesis of self-healing polymer, measurement of mechanical properties (tensile test, indentation DMA, cycling test, adhesion test) and self-healing properties (scratch/cut test), analysis of thermal properties (DSC, TGA) and spectroscopy (FT-IR)
Required Skills for the Internship: *(max. 50 words)*	Team work ability, background in Chemistry, Physics, Engineering or Biology, fluency in English or French.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Fabio Cicoira Title: Professor Department: Chemical Engineering Website: https://www.polymtl.ca/iontronics/en/people

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Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☐ Mathematics/Industrial	☐ Biomedical ☐ Computer/Software ☐ Mechanical	☑ Chemical ☐ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	Surface engineering of materials		
University Cycle :	☑ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Often, we need the surface of a material to serve a different function from what its native properties allow. Photo-initiated chemical vapour deposition (PICVD) and Dip-dip-dry (DDD) show promise as scalable processes to facilitate surface engineering, to meet the needs of a various processes. Work at Polytechnique Montreal's PhotoSEL (photochemical surface engineering laboratory) has focused on adapting these methods to tailor the surface properties of metal surfaces, polymers and nanoparticles of various types at both small and large scales. This internship would aim to modify a variety of surfaces finding use in agriculture, advanced materials, 3D printing, and water harvesting.		
Tasks during the Internship: *(max. 50 words)*	Plan and execute experiments, analyze experimental results, construct/adapt chemical reactors, write progress reports, present results orally.		
Required Skills for the Internship: *(max. 50 words)*	Chemical reactions or polymers (at least one is a must), photochemistry (or a desire to learn), nanomaterials (or willingness to learn), chemical analysis (basics)		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: TAVARES, Jason Robert Title: Full professor Department: Chemical Engineering Website: jasontavares.ca		

* Please consult your advisor at the Office of Research & Centre for Technological Development to determine whether the proposed project raises issues with regard to confidentiality or intellectual property.

PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Biomedical ☑ Chemical ☑ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Study of bioaerosols from wastewater treatment processes
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Municipal and industrial wastewater treatment plants (WWTP) are sources of bioaerosols that can harbor pathogenic or antibiotic-resistant bacteria, leading to health issues for workers. It is necessary to evaluate the operating and environmental factors that promote the presence and spread of these pathogens. The project aims to identify operating and control factors that reduce WWTP workers' exposure to bioaerosols. An environmental assessment will be conducted in 15 WWTPs to document configurations and operating parameters of the selected systems. Air and water sampling will be performed to characterize the aerosols generated according to the type of process, operating parameters and wastewater.
Tasks during the Internship: *(max. 50 words)*	Visit of 15 selected WWTPs and characterization (type of water and air treatment equipment, operating parameters and biological characterization of the wastewater); Planning of sampling campaign; Preparation of sampling material; Lab analysis for physical and microbiological analyses of water and aerosols; Data analysis.
Required Skills for the Internship: *(max. 50 words)*	The required skills include : teamwork, rigor, autonomy, understanding of wastewater treatment processes, data organization and analysis, eagerness to learn, knowledge of environmental microbiology, including lab experience. The ability to read French is an asset. Possibility to pursue as a PhD student if there is interest.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Emilie Bédard Title: Assistant Professor Department: Department of Civil, Geological and Mining Engineering Website: https://www.polymtl.ca/expertises/bedard-emilie-0

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Civil, Geological, Mining ☐ Mathematics/Industrial	☐ Biomedical ☐ Computer/Software ☐ Mechanical	☐ Chemical ☐ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	UHPFRC : From material development to structural applications		
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)		
Background Information: *(max. 100 words)*	In the last decade ultra-high performances fiber reinforced concretes (UHPFRC) have been developped. They present very high mechanical properties, and very low porosity and permeability. One UHPFRC have been developed at Polytechnique Montreal. The goal of the internship will be either : to modify the UHPFRC mix in order to reduce its CO_2 emissions and increase its mechanical properties by using special mineral admixture, or to develop and test in laboratory structural applications (bridge beams, slabs, barriers) designed with the UHPFRC. The types of activities to be carried out will be adapted according to the academic background of the candidate (1st, 2nd or 3rd cycles).		
Tasks during the Internship: *(max. 50 words)*	• Produce UHPFRC mixes or structural applications at the laboratory • Measure UHPFRC properties at fresh and hardened states with standard lab. tests or measure the structural behavior of applications with specific tests • Analysis of results and production of a technical report		
Required Skills for the Internship: *(max. 50 words)*	• Excellent leadership and be autonomous to manage technical activities • Good knowledge of concrete production and properties, lab experience is an asset • Good dexterity and be familiar with manual works to carry out lab activities • Excellent knowledge of Excel and Word software in order to analyze results		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Jean-Philippe Charron Title: Full Professor in Civil Engineering Department: Civil, Geological and Mining Engineering Website: https://www.polymtl.ca/expertises/en/charron-jean-philippe		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Civil, Geological, Mining ☐ Mathematics/Industrial	☐ Biomedical ☐ Computer/Software ☐ Mechanical	☐ Chemical ☐ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	Soil erosion in vineyards in the context of climate change		
University Cycle :	☐ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	According to the sixth IPCC's report, "Climate-related extremes have affected the productivity of agricultural […] sectors". For example, high precipitation events increase erosion processes and reduce the productivity of a field. In this context, the project will focus on the prevention of soil erosion in vineyards which will constitute a field test for a soil improvement technique developed in Polytechnique Montréal. This technique is based on chemical and biochemical reactions that lead to the creation of bonds in a soil while keeping it permeable. These bonds reduce surface erosion and the project aims to evaluate their application in agricultural fields.		
Tasks during the Internship: *(max. 50 words)*	Literature review, laboratory tests to evaluate the potential impact of chemicals on the vines, erosion and permeability tests to evaluate the efficiency of the technique on real vineyards soils, field tests on vineyards to evaluate the applicability of the technique on site and its efficiency (to be confirmed).		
Required Skills for the Internship: *(max. 50 words)*	- Abilities in conducting laboratory and field tests, - Good sense of initiative, - Field of expertise: hydraulics, soil erosion, viticulture (an asset).		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: field test sites. ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Benoît Courcelles Title: Associate professor Department: Civil, geological and mining engineering Website: https://www.polymtl.ca/expertises/courcelles-benoit		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☑ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Crack propagation in geomaterials in reduced gravity conditions
University Cycle :	☐ 1st cycle (Undergraduate) ☐ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	In this research, we aim to understand the mechanism of crack propagation in reduced gravity conditions in geomaterials. Cracks can be induced in geomaterials due to temperature variation, vibration, impact, and so on. The mechanical behavior of geomaterials in terms of resistance and stiffness in reduced gravity conditions can be different compared to the 'g' condition.
Tasks during the Internship: *(max. 50 words)*	- Literature review - Develop the fundamental concepts - Develop the theoretical framework
Required Skills for the Internship: *(max. 50 words)*	- Geomechanics - Computational mechanics
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Pooneh Maghoul Title: Associate Professor Department: Civil, Geological and Mining Engineering Website: https://www.siglab.ca/

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Civil, Geological, Mining ☐ Mathematics/Industrial	☐ Biomedical ☐ Computer/Software ☐ Mechanical	☐ Chemical ☐ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	Geotechnical Design Paradigms in Reduced Gravity Conditions		
University Cycle :	☑ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	The proposed research aims to contribute to the development of guidelines on the design of resilient infrastructures, earthworks, and the consideration of seismicity in the design of lunar infrastructure.		
Tasks during the Internship: *(max. 50 words)*	- Literature review - Develop the fundamental concepts - Critical thinking - Numerical modeling		
Required Skills for the Internship: *(max. 50 words)*	- Soil mechanics - Geomechanics - Foundation design - Numerical modeling		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Pooneh Maghoul Title: Associate Professor Department: Civil, Geological and Mining Engineering Website: https://www.siglab.ca/		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Civil, Geological, Mining ☐ Mathematics/Industrial	☐ Biomedical ☐ Computer/Software ☐ Mechanical	☐ Chemical ☐ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	Co-disposal of waste rock and mine tailings		
University Cycle :	☑ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Waste management is a relevant topic in mining operations, as instabilities could occur depending on the disposal approach. Waste rocks are typically stored in piles, while tailings are released in tailing impoundments. Nonetheless, the behaviour of both type of waste could trigger indelible damage in the field. Tailing present limited shear strength, while waste rock (WR) is exposed to acid rock drainage (ARD). Co-disposal of waste rock and tailings (WR&T) could be an alternative to take advantage of (1) the mechanical properties of WR to mitigate tailings liquefaction, and (2) the hydraulic properties of tailings to avoid ARD in WR.		
Tasks during the Internship: *(max. 50 words)*	Evaluate experimentally the mechanical and hydro-geotechnical behaviour of WR&T interaction in the laboratory.		
Required Skills for the Internship: *(max. 50 words)*	Basic knowledge on geotechnical engineering and laboratory testing.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Carlos Ovalle Title: Associate Professor Department: Department of Civil, Geological and Mining Engineering Website: https://www.polymtl.ca/expertises/en/ovalle-carlos		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☑ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Mechanical behavior of coarse mine waste rock
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Rockfills are largely used in civil engineering works, such as dams, coarse drains and mine waste rock dumps, for instance. However, data on their mechanical properties are quite scarce because of the lack and high cost of the required large laboratory devices. The main scope of the project is to study particle size effects on the strength of waste rock. A series of shearing and compression tests will be carried out on large laboratory devices.
Tasks during the Internship: *(max. 50 words)*	A series of shearing and compression tests will be carried out on a direct shear for samples sized 300/300/150mm and a large triaxial cell for samples of 300mm in diameter and 600mm in height.
Required Skills for the Internship: *(max. 50 words)*	Basic knowledge on geotechnical engineering and laboratory testing.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Carlos Ovalle Title: Associate Professor Department: Department of Civil, Geological and Mining Engineering Website: https://www.polymtl.ca/expertises/en/ovalle-carlos

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☑ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Collaborative Simultaneous Localization And Mapping
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Collaborative Simultaneous Localization And Mapping is an essential perception algorithm to enable multi-robot behaviors. In this project, we want to deploy our technique in challenging environments with different sensors (cameras, lidars, etc.).
Tasks during the Internship: *(max. 50 words)*	Learn about robotic perception. Setup sensors on real robots (calibration, configuration, etc.). Help with the field experiments. Various software engineering tasks to make sure that the experiments are stable and repeatable.
Required Skills for the Internship: *(max. 50 words)*	- Familiarity with C++ and Python. - Familiarity with ROS, CMake and Docker (preferred) - Interest in mobile robotics.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Giovanni Beltrame Title: Professor Department: Computer and Software Engineering Website: https://mistlab.ca

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☑ Computer/Software ☑ Electrical ☑ Mathematics/Industrial ☐ Mechanical ☑ Physics
Research Project Title : *(max. 10 words)*	A.I.-control of neurostimulation interfaces
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	The sciNeurotech Lab develops A.I. technology enabling unprecedented control of neuromodulation delivery. Neuromodulation means stimulation therapies through electrical interfaces with the nervous system. These medical devices can help recovery mobility, communication and sensation after a neurotrauma or disease. We use Bayesian Optimization (BO) for personalized and efficient maximization of neurostimulation efficacy. You can think of it as a self-drive module for neurostimulation. A current limitations is that neural interfaces are inherently unstable: challenges include loss of electrodes, gains/loss of stimulation efficacy due to changes in the interface, network changes due to learning or plasticity.
Tasks during the Internship: *(max. 50 words)*	You will develop a theoretical novelty in A.I. optimization of neuromodulation, allowing our framework to handle non-stationarities typical of neural interfaces. You will code, validate in silico (and optionally in vivo) a new BO-based technique.
Required Skills for the Internship: *(max. 50 words)*	- Very proficient coding for machine learning / A.I. - Programming in Python and/or Matlab.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name:　　Marco Bonizzato Title:　　Assistant Professor Department:　Electrical Engineering Website:　　https://www.polymtl.ca/expertises/en/bonizzato-marco

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☑ Physics
Research Project Title : (max. 10 words)	Neuroprosthesis to reverse paralysis after spinal cord injury
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: (max. 100 words)	The sciNeurotech Lab develops neuroprosthetic therapies. Neuroprostheses are electrical interfaces with the nervous system, which can let the user recovery mobility, communication and sensation after a neurotrauma or disease. We are currently developing a novel cortical neuromodulation intervention to improve reaching and grasping movements after spinal cord injury. We implant rats with cortical brain interfaces (similar to "Neuralink", but used to stimulate the neural circuits) and we study the controllability of cortical stimulation on hand function. After a spinal cord injury, we are able to reverse motor deficits and recover hand/arm function.
Tasks during the Internship: (max. 50 words)	You will perform in vivo behavioral experiments in rats and collect kinematic data to study and optimize the control of movement that can be obtained by delivering cortical neuromodulation.
Required Skills for the Internship: (max. 50 words)	- Behavioral animal research: patience, care, integrity. - Kinematic analysis: handling Matlab or Python code. - Ideal profile: competence in automation and control engineering.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: UdeM building (5min walk) ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Marco Bonizzato Title: Assistant Professor Department: Electrical Engineering Website: https://www.polymtl.ca/expertises/en/bonizzato-marco

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Privacy-preserving data analysis
University Cycle :	☐ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Monitoring and controlling large-scale infrastructure systems (ex: transportation or energy systems) typically requires collecting large amounts of data from the private users interacting with these systems. A fundamental challenge is to design high-performance systems that also provide privacy guarantees to these users. The notion of differential privacy (DP) serves as a gold standard definition of privacy. My group has developed a number of techniques for the differentially private (d.p.) analysis of streaming / time-varying data.
Tasks during the Internship: *(max. 50 words)*	1) Develop d.p. data analysis techniques for our current projects (ex: clustering of time-series data, distributed signal processing, etc.) 2) Apply your results to transportation systems, or energy systems (demand response programs). 3) Develop simulations to evaluate performance/privacy tradeoffs.
Required Skills for the Internship: *(max. 50 words)*	- Probabilistic modeling of time series data, statistical signal processing, stochastic systems and control, etc. - Mathematical maturity, interest in theoretical computer science. - Basic coding skills.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: LE NY, Jérôme Title: Associate Professor Department: Electrical engineering Website: http://www.professeurs.polymtl.ca/jerome.le-ny/

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☐ Physics		
Research Project Title : *(max. 10 words)*	Combinatorial Optimization for Geospatial Wind Turbine Placement		
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)		
Background Information: *(max. 100 words)*	Wind turbines that are geographically spread typically lead to a power generation with a reduced correlation between each other. Intermittency which can affect power generation on second, day or month timescales is an important challenge in renewable system operations. Hence, to offer a renewable production with low variance, wind turbines should be distributed on distant sites whose meteorological conditions correlation is low. As part of this research project, the candidate will develop a wind turbine optimal placement method which promotes stable operating conditions in addition to other physical, social, and economic factors that may influence the success of a wind-powered grid.		
Tasks during the Internship: *(max. 50 words)*	- Process the open data sets like GPS and meteorological data. - Model the placement problem as a mixed-integer convex optimization problem. - Develop a machine learning method to rapidly exclude non-compatible sites.		
Required Skills for the Internship: *(max. 50 words)*	Experience in object-oriented programming (e.g., Python); background knowledge in power systems and optimization; experience in working with geospatial data (GeoPandas, GeoJson); interest in the field of renewable energy. Knowledge in machine learning and prior knowledge in web interface development (an asset).		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Antoine Lesage-Landry Title: Assistant Professor Department: Electrical Engineering Website: https://www.polymtl.ca/expertises/en/lesage-landry-antoine		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☑ Physics
Research Project Title : *(max. 10 words)*	Novel optical fiber sensor development and applications
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Optical fiber sensors are more and more widely used in both industrial and biomedical applications. Immune to electromagnetic interference and ultra-precise, these new types of sensors can do distributive measurement, that is they can measure all along the optical fiber giving spatial information. The projects proposed here involve the development of new applications of incoherent fiber Bragg grating sensors such as robotic or biomedical shape sensing or for magnetic sensing intended for fusion reactors (Tokamaks). New types of sensors leading to lab-in-a-fiber is also a possibility of development. These projects involve designing, building and testing the both the interrogation system as well as the sensor itself.
Tasks during the Internship: *(max. 50 words)*	The candidate will be tasked with numerical modelling as well as experimental work in the laboratory involving laser operation, optical fiber manipulation, electrical and optical system design. The candidate will be required to mount an experiment, analyse results and compare with expected model.
Required Skills for the Internship: *(max. 50 words)*	The applicant must have a good scientific curiosity as well as a good initiative to solve problems. The candidate should be experience in Matlab or Python and be comfortable in numerical simulation. Good background knowledge in optics/photonics and optical fibers is required.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Sébastien Loranger Title: Assistant Professor Department: Electrical Engineering Website: https://www.polymtl.ca/expertises/en/loranger-sebastien-0

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☐ Mechanical ☑ Physics
Research Project Title : *(max. 10 words)*	Novel photonic devices and integration by laser fabrication techniques
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Laser fabrication techniques for microstructures, such as cutting/ablation, ultra-fast induced refractive index change and 3D printing have significantly improved in the last decade and have unlocked a new horizon of photonic crystals and integrated photonic devices. For instance, writing waveguide and microstructures in flexible and biocompatible substrate now allows for tunable photonic devices with biomedical applications. High resolution 3D printing can now enable advanced photonic crystals in the THz range. Combining all those instances enables new photonic/THz integration options which can be applied to telecommunications and sensors. The projects here involve exploring, designing and testing new devices along those lines.
Tasks during the Internship: *(max. 50 words)*	The candidate will be tasked with numerical modelling as well as experimental work in the laboratory involving laser operation, optical fiber manipulation, 3D modelling and printing, electrical and optical system design. The candidate will be required to mount an experiment, analyse results and compare with expected model.
Required Skills for the Internship: *(max. 50 words)*	The applicant must have a good scientific curiosity as well as a good initiative to solve problems. The candidate should be experience in Matlab or Python and be comfortable in numerical simulation. Good background knowledge in optics/photonics or RF/THz waves and waveguides/optical fibers is required.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Sébastien Loranger Title: Assistant Professor Department: Electrical Engineering Website: https://www.polymtl.ca/expertises/en/loranger-sebastien-0

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☑ Electrical ☑ Mathematics/Industrial ☐ Mechanical ☑ Physics
Research Project Title : *(max. 10 words)*	Optimality in photonic design
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Through geometric material structuring at or below the characteristic wavelength, nanophotonics enables an astounding level control over optical properties: the propagation of light has been slowed by more than two orders of magnitude; given opposite wavefront and energy propagation directions; confined to volumes nearly a hundred times smaller than its free-space wavelength; and trapped, with minimal amplitude decay, in micron sized areas for tens of millions of oscillations. The goal of this project, in brief, is to assist in a larger, ongoing, effort to mathematically describe exactly how far this structural control extends.
Tasks during the Internship: *(max. 50 words)*	Apply and develop inverse design algorithms to enhance radiative emission from a magnetic dipole. Determine fundamental limits on the extent that radiative emission from a magnetic dipole can be enhanced.
Required Skills for the Internship: *(max. 50 words)*	A strong back ground in electromagnetics and scientific programming. Previous experience in optimization theory and integral modelling techniques would be helpful.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Sean Molesky Title: Assistant Professor Department: Engineering Physics Website: https://polymtl.ca/expertises/en/molesky-sean

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace	☑ Biomedical	☑ Chemical
	☐ Civil, Geological, Mining	☐ Computer/Software	☑ Electrical
	☐ Mathematics/Industrial	☐ Mechanical	☑ Physics
Research Project Title : *(max. 10 words)*	Algorithms for 3D nanoscale tracking		
University Cycle :	☐ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	3D particle tracking has applications in a wide variety of areas including health, materials, aeronautics, and more. The Weiss lab is developing new software tools to make this easier, and in particular, to understand the behaviors of nanoscale materials interacting with biological cells. Here we a		
Tasks during the Internship: *(max. 50 words)*	Develop a set of software tools and deploy them to track the behaviors of single proteins, nanoparticles, and even cancer cells, revealing the behaviors and underlying mechanisms therein.		
Required Skills for the Internship: *(max. 50 words)*	Math at calculus or above. Programming experience in Python and/or Matlab. Knowledge in one of hte following areas: cell biology, optics, statistical mechanics.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☑ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Lucien Weiss Title: Assistant Professor Department: Engineering Physics Website: www.WeissLab.ca		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☑ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☑ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☑ Physics
Research Project Title : *(max. 10 words)*	Flow-based 3D imaging of cells for diagnostics
University Cycle :	☐ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	The Weiss Lab develops high-resolution/high-throughput microscopes that can be used to image thousands of cells per minute. This enables large heterogeneous populations of samples to be characterized to detect subtle differences indicative of infection. Alternatively, we can deploy the same instruments to understand how potential therapeutics interact with target cells study action mechanisms. In either case, we use a combination of novel instruments, biochemistry, and cellular biophysics to achieve these goals.
Tasks during the Internship: *(max. 50 words)*	Learn to construct and align a state-of-the-art 3D microscope.
Required Skills for the Internship: *(max. 50 words)*	Understanding of instrument engineering, Background in at least one of the following: fluorescence spectroscopy, microfluidics, optics
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Lucien Weiss Title: Assistant Professor Department: Engineering Physics Website: www.WeissLab.ca

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace	☑ Biomedical	☑ Chemical
	☐ Civil, Geological, Mining	☐ Computer/Software	☐ Electrical
	☐ Mathematics/Industrial	☑ Mechanical	☑ Physics
Research Project Title : *(max. 10 words)*	How to defeat bacterial biofilms?		
University Cycle :	☐ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	The Weiss Lab develops high-resolution microscopes that can be used to study the nanoscale behaviors of cells and particles in complex materials. We are using these tools to better understand (1) how cells attach to surfaces and form biofilms, (2) how to prevent surface fouling, and (3) how to break up existing biofilms by exploiting nanoscale cracks forming between cells.		
Tasks during the Internship: *(max. 50 words)*	Learn to construct and align a state-of-the-art 3D microscope, develop characterization tools to quantify biofilm formation, evolution, and destruction		
Required Skills for the Internship: *(max. 50 words)*	Instrument engineering, math at calculus or above. Background in at least one of the following: fluorescence spectroscopy, microbiology, optics.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Lucien Weiss Title: Assistant Professor Department: Engineering Physics Website: www.WeissLab.ca		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☑ Mathematics/Industrial	☐ Biomedical ☐ Computer/Software ☐ Mechanical	☐ Chemical ☐ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	Bayesian methods for stochastic blackbox optimization		
University Cycle :	☐ 1st cycle (Undergraduate)	☑ 2nd cycle (Master)	☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	This internship aims at devloping new methods for computationally expensive BlackBox optimization (BBO). BBO refers to situations where the structure of the objective function and the constraints is unkown and cannot be exploited. BBO methods are playing a key role in automated systems; more and more applications related machine-learning and engineering design require solving challenging BBO problems. In this context, there has been a growing interest in two class of methods: Derivative-Free optimization (DFO) and Bayesian Optimization (BO). Despite addressing the same problems, only few interactions between DFO and BO were established.		
Tasks during the Internship: *(max. 50 words)*	Recently, we investigated the use of a trust-region methodology within BO. The resulting BO method, name TREGO, is very commpetitive with state-of-the-art BBO methods. The intern will extend TREGO to solve stochastic BBO problems. The method will be tested on analytical benchmarks and machine-learning applications.		
Required Skills for the Internship: *(max. 50 words)*	- Numerical linear algebra; - Statistics and probability; - Numerical optimization; - Programming skills (Python or C++).		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☑ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Youssef Diouane Title: Adjunct Professor Department: Mathematics and Industrial Engineering Website: https://www.polymtl.ca/expertises/en/diouane-youssef		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace	☐ Biomedical	☐ Chemical
	☐ Civil, Geological, Mining	☑ Computer/Software	☐ Electrical
	☑ Mathematics/Industrial	☐ Mechanical	☐ Physics

Research Project Title : (max. 10 words)	Effects of an Automated Diagnostic Algorithm on Human Trust

University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)

Background Information: (max. 100 words)	During a major failure in complex systems, a failure can affect multiple related systems and trigger an alarm flood. These alarm floods can be troublesome for operators trying the determine the source of the fault because the quantity of alarms is too numerous to manage. Recent research has developed algorithms able to identify automatically the cause of alarm floods and propose diagnosis to the operator, however, limited studies have been done on the interactions between the human and the automated diagnostic of failure in process control. The objective of this study is to investigate how the automated diagnostics of faults affects the operator's decision-making, trust in the machine, and performance during high-workload scenarios.

Tasks during the Internship: (max. 50 words)	To this end, a simulated process control environment (simulating an automated diagnostic algorithm) was developed to enable interactions between operators and alarm diagnostics. The main task during the internship will be to support the main researchers in: 1) performing user testing with participants using the simulator, 2) gathering data, 3) analysing data, and 4) article writting.

Required Skills for the Internship: (max. 50 words)	Interpersonal skills, autonomous, great communication skills, works wells in a team, organized and meticulous, and have interest in the domain! Having experience with MATLAB, data analysis and human factors is a plus.

Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No

Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☑ This project can be offered remotely if the sanitary situation requires so

Supervisor:	Name: Philippe Doyon-Poulin Title: Professor Department: Department of Mathematical and Industrial Engineering Website: https://www.polymtl.ca/expertises/en/doyon-poulin-philippe

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☑ Computer/Software ☐ Electrical ☑ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Assessing the robustness of accounting data for carbon neutrality plan
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Faced with the major challenges raised by climate change, a growing number of governments and organizations are committing to reducing their greenhouse gas emissions to become carbon neutral. Developing a decarbonization plan first requires accurate carbon footprinting of human activities. Several methods and data sources are available to perform these quantifications. However, their quality and the impact of this quality on the robustness of the carbon quantifications is poorly known, despite the existing mathematical tools to estimate this robustness. Quantifications that are too uncertain could compromise the effectiveness of decarbonization plans and the ability to become a carbon neutral society.
Tasks during the Internship: *(max. 50 words)*	Analysing carbon footprinting methods (GHG Protocol, LCA, national inventories), mapping accounting data and emission factor sources, assessing their quality (using the Pedigree matrix), and performing case studies on one or several sectors to evaluate quality issues, best data sources, as well as new data to develop in priority.
Required Skills for the Internship: *(max. 50 words)*	Rigor, ability to summarize, data analysis. Following knowledges are an asset: carbon footprinting methods such as life cycle assessment, Monte Carlo simulations, Oracle Crystal Ball
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☐ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: CIRAIG, 3333 QUEEN MARY ROAD ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Manuele Margni Title: Professor Department: Mathematics & industrial engineering Website: https://www.polymtl.ca/expertises/margni-manuele

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☑ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : (max. 10 words)	Exploring and criticizing possible transition pathways to achieve carbon neutrality
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: (max. 100 words)	The security and survival of the human species will depend in part on its will to halt climate changes by reducing its greenhouse gas emissions until it achieves carbon neutrality. Historical trends only show weak signals of possible decarbonization. However, complex socio-economic evolution models, called Integrated Assessment Models (IAM), aim to define combinations of parameters to achieve these objectives. The objective of this internship is to carry out a critical analysis of the existing IAM and transition pathways, including those used by the IPCC, in order to produce recommendations relating to planning trajectories towards sustainable carbon neutrality.
Tasks during the Internship: (max. 50 words)	Mapping IAMs; Analysing their structures, usages and sustainability dimensions; Understanding and analysing key parameters; Evaluating the potential of requestioning growth and ever rising demand.
Required Skills for the Internship: (max. 50 words)	Rigor, ability to summarize, literature review, ability to work in team, data analysis. Following knowledges are an asset: technico-economic modeling, integrated model assessments.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☐ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: CIRAIG, 3333 Queen Mary Rd ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Manuele Margni Title: Professor Department: Mathematics & industrial engineering Website: https://www.polymtl.ca/expertises/margni-manuele

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Civil, Geological, Mining ☑ Mathematics/Industrial	☐ Biomedical ☑ Computer/Software ☐ Mechanical	☐ Chemical ☐ Electrical ☐ Physics
Research Project Title : *(max. 10 words)*	Reliability of petroleum emission factors towards carboneutrality		
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)		
Background Information: *(max. 100 words)*	Oil consumption is responsible for around one third of global greenhouse gas (GHG) emissions. This is at least the current estimate, because these emissions could be greatly underestimated, due to the limits of carbon footprinting models for oil extraction, which should ideally represent each of the current practices and technologies of the extracting countries. Thus, global GHG emissions may currently be underestimated, with serious consequences on carbon neutrality planning. The objective of the internship is to audit oil extraction data and GHG quantification models to guide future research to make these models more reliable.		
Tasks during the Internship: *(max. 50 words)*	Mapping oil extraction emission factors & associated models, assessing their quality, perform a comparison, scale up the emissions with different models at the global scale, give recommendations on future research developments and their importance for carbon neutrality planning, look for industrial partners to develop this research.		
Required Skills for the Internship: *(max. 50 words)*	Rigor, ability to summarize, data analysis. Following knowledges are an asset: carbon footprinting methods such as life cycle assessment, petroleum industry.		
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No		
Location:	☐ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: CIRAIG, 3333 QUEEN MARY ROAD ☐ This project can be offered remotely if the sanitary situation requires so		
Supervisor:	Name: Manuele Margni Title: Professor Department: Mathematics & industrial engineering Website: https://www.polymtl.ca/expertises/margni-manuele		

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☑ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☑ Mathematics/Industrial ☐ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Sustainability risks around strategical metals for the energy transition
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	The necessary energy transition to stabilize the climate requires many metals whose future availability is uncertain. Nevertheless, the future demand for strategic metals depends on many factors, including the choice of energy technologies to replace fossil fuels. Moreover, the increase in demand for metals must lead to environmental burden shifting. Some methods and data to quantify the environmental impacts relating to metals extraction and transformation already exist, including advanced dynamic tools to simulate future impacts. Thus, quantitatively predicting these environmental burden shifts is possible, to correctly support policies around the energy transition and the issue of strategic and critical metals.
Tasks during the Internship: *(max. 50 words)*	Mapping, analysis and synthesizing future strategic metal demand trends; Estimating strategic metal consumptions in main energy transition technologies based on literature (e.g. Life Cycle Assessments or Material Flow Analyses); Quantifying future environmental impacts under different metal demand scenarios.
Required Skills for the Internship: *(max. 50 words)*	Rigor, ability to summarize, literature review, ability to work in team, data analysis. Following knowledges are an asset: life cycle assessment, material flow analysis, coding (python).
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☐ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☑ Other, please specify: CIRAIG, 3333 QUEEN MARY ROAD ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: Manuele Margni Title: Professor Department: Mathematics & industrial engineering Website: https://www.polymtl.ca/expertises/margni-manuele

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace	☐ Biomedical	☐ Chemical
	☐ Civil, Geological, Mining	☐ Computer/Software	☐ Electrical
	☐ Mathematics/Industrial	☑ Mechanical	☐ Physics

Research Project Title : *(max. 10 words)*	Compliance measurement of machine tools

University Cycle :	☐ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)

Background Information: *(max. 100 words)*	During machining cutting forces cause tool to workpiece deflection due to machine compliance. Compliance is the inverse of stiffness. Excessive or unexpected changes in compliance may also occur due to machine malfunctions. Automating tests to quantify compliance would allow regular monitoring of machine compliance to detect malfunctions before they result in the production of bad parts or machine breakdown with the consequent loss of productivity. Some intial work was conducted using a loaded ballbar with promising results but less intrusive approaches are sought for industrial use.

Tasks during the Internship: *(max. 50 words)*	Plan and conduct, with the assistance of CNC technician, compliance test on a five axis machine tool, present the data in an informative format for analysis and draw conclusions on the machine performance.

Required Skills for the Internship: *(max. 50 words)*	- Good understanding of fundamental mechanical engineering principles of stiffness; - Some familiarity with instrumentations, data aquisition and analysis; - Computational programming using Matlab for example.

Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No

Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so

Supervisor:	Name: René Mayer (Authoring as J R R Mayer) Title: Professor Department: Mechanical Engineering Website: https://www.polymtl.ca/expertises/en/mayer-rene

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Error motion of rotary axes
University Cycle :	☐ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Five axis CNC machine tools have two rotary axes. Such axes exhibit small motion errors. While spindles, rotating the cutting tool, have received much attention, the rotary axes used to orient the tool relative to the workpiece have not been so much studied. The research aims at providing simple means for a CNC machine to automatically verify the performance of its rotary axes in terms of five of its six error motions thus excluding angular positioning performance.
Tasks during the Internship: *(max. 50 words)*	- Familarise with the laboratory instruments; - Conceive a reversal methods to separate error contributors from the raw; - Derive the necessary mathematics for data analysis; - Conduct tests, analyse and conclude.
Required Skills for the Internship: *(max. 50 words)*	- Basic skills in data aquisition and data analysis; - Basic knowledge of kinematics; - Computational programming using Matlab for example;
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☑ Yes ☐ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: René Mayer (Authoring as J R R Mayer) Title: Professor Department: Mechanical Engineering Website: https://www.polymtl.ca/expertises/en/mayer-rene

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Design and fabrication of multistable, origami-inspired structures
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	As humans, we rely on deployability for the most basic tasks (e.g., folding a packaging box) as well as for immensely complex feats of engineering (e.g., deploying solar sails for spacecraft propulsion). The art of origami is used more and more in engineering systems that demand large shape transformation. The objective of the project is the the design and manufacturing of deployable and multistable structures inspired by origami. The student will use simple design rules to transform structures that are initially compact to functional shapes such as arches, domes, and booms.
Tasks during the Internship: *(max. 50 words)*	Creation of a library of multistable origami structures using the existing design toolbox (python); Classification of the obtained shapes; Inverse design the folding pattern to program shapes such are arches, domes, booms, etc.; Fabrication of the origami structures using 2d (laser-cutter) & 3d (additive manufacturing) techniques.
Required Skills for the Internship: *(max. 50 words)*	To conduct this research project, the ideal student should be creative, self-driven, familiar with computer aided design, programming, the finite elements method, and prototyping via 3d-printing.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☑ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: David Mélançon Title: Assistant Professor Department: Mechanical Engineering Website: 1.https://dmelancon.com

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☐ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Optimizing the functionality of soft robots through mechanical instabilities
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Soft robots capable of undergoing large deformation find immediate applications where safety, adaptability, and shape-morphing are required. Their superiority over traditional robots becomes evident when they are designed to support elastic instabilities, such as shell buckling, as it can lead to novel functionality including the sudden release of energy. The interplay between the shell's geometry, type of mechanical instability, and post-buckling deformation is highly nonlinear, but can be predicted with numerical tools (e.g., FEM). By programming the geometry of the robot to trigger a precise release of energy upon buckling, these robots could be use for minimally invasive surgery.
Tasks during the Internship: *(max. 50 words)*	1- Parametrization of the shell's geometry, materials, and boundary conditions in python; 2- Simulation of the post-buckling regime of the shell via the finite elements method in Abaqus to extract the elastic energy released upon bucking; 3- Optimizing the design of the shell for a prescribed energy release.
Required Skills for the Internship: *(max. 50 words)*	The student should be familiar with programming (ideally the language python), the finite elements method (ideally the software Abaqus), and derivative-free optimization methods (direct search, GA, CMA-ES, etc.). Ideally, the student has an interest for fabrication and experimental work to validate the results.
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☐ Yes ☑ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☑ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: David Mélançon Title: Assistant Professor Department: Mechanical Engineering Website: 1.https://dmelancon.com

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PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☑ Chemical ☐ Civil, Geological, Mining ☐ Computer/Software ☐ Electrical ☐ Mathematics/Industrial ☑ Mechanical ☐ Physics
Research Project Title : *(max. 10 words)*	Experimental Investigation of Foam Growth Dynamics
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☐ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Thermoplastic polymer foams are commonly used in the transportation (e.g., for insulating car and aircraft engines and cabins), construction and packaging industries for their good mechanical properties in relation to their light weight and insulation/ barrier properties. The key to manufacturing such foams lies in a better understanding of the nucleation, growth and stabilization mechanisms of bubbles, which are complex and difficult to predict. A PhD project has been focusing on attempting to model such materials formation using numerical simulations. The validation of the numerical model consists in confronting the model predictions with experimental data and is a crucial step in the model development.
Tasks during the Internship: *(max. 50 words)*	The goal of the intern will be to retrofit an existing experimental foam reactor and conduct a series of experiments under the direct supervision of the PhD student and the professor involved in order to generate experimental data for validating the numerical model.
Required Skills for the Internship: *(max. 50 words)*	Primary importance: good laboratory skills, meticulousness, ability to work in a team An asset: knowledge in polymer engineering and/or foam and/or fluid mechanics and/or design of experiments and/or image analysis
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☐ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: David Vidal Title: Assistant professor Department: Mechanical Engineering Website: https://www.polymtl.ca/expertises/vidal-david

* Please consult your advisor at the Office of Research & Centre for Technological Development to determine whether the proposed project raises issues with regard to confidentiality or intellectual property.

PROJECT DESCRIPTION
2023 Summer Research Internship Program

Main area of expertise :	☐ Aerospace ☐ Biomedical ☑ Chemical ☑ Civil, Geological, Mining ☑ Computer/Software ☐ Electrical ☑ Mathematics/Industrial ☑ Mechanical ☑ Physics
Research Project Title : *(max. 10 words)*	Modeling the Transport of Sediments in Rivers using the Lattice Boltzmann Method
University Cycle :	☑ 1st cycle (Undergraduate) ☑ 2nd cycle (Master) ☑ 3rd cycle (Ph.D.)
Background Information: *(max. 100 words)*	Commercial codes (e.g. Delft3D) exist to model the morphological evolution of rivers and coasts and the transport of sediments under extreme hydrological events using classical numerical methods (FEM, FDM or FVM). Although relatively new in this context, the Lattice Boltzmann method (LBM) has advantageous properties such as a local numerical scheme that makes it very efficient for simulating flows through complex structures and particularly well suited to run on high-performance computer clusters. These properties allow the simulation of very complex and large-scale flow domains, such as river basins and coastal regions, at fine resolution by solving a multilayer shallow water equation coupled with a sediment transport equation.
Tasks during the Internship: *(max. 50 words)*	1) Adapt an existing open-source LBM code for solving a multilayer shallow water equation problem based on recently proposed algorithms from the literature; 2) Verify and validate the modified code on existing test cases and experimental data available from the literature.
Required Skills for the Internship: *(max. 50 words)*	Primary importance: good programming skills An asset: knowledge in fluid mechanics and/or Computational Fluid Dynamics and/or parallel computing and/or river modelling
Confidentiality and Intellectual Property *	Will the signature of a **"Confidentiality Agreement"** be required? ☐ Yes ☑ No Will the signature of an **"Assignment of Intellectual Property"** be required? ☑ Yes ☐ No
Location:	☑ Polytechnique's Building (Main, Lassonde, Bombardier, Aisenstadt) ☐ Other, please specify: ☑ This project can be offered remotely if the sanitary situation requires so
Supervisor:	Name: David Vidal Title: Assistant professor Department: Mechanical Engineering Website: https://www.polymtl.ca/expertises/vidal-david

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