# CREATE-U

## Combining Research Experience and Technical Electives for Undergraduates

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## WHY RESEARCH?

Because you like asking questions

Because you can learn how to find answers

Because you want to know more

Because you want to make a contribution to what we know

## WHY CREATE-U?

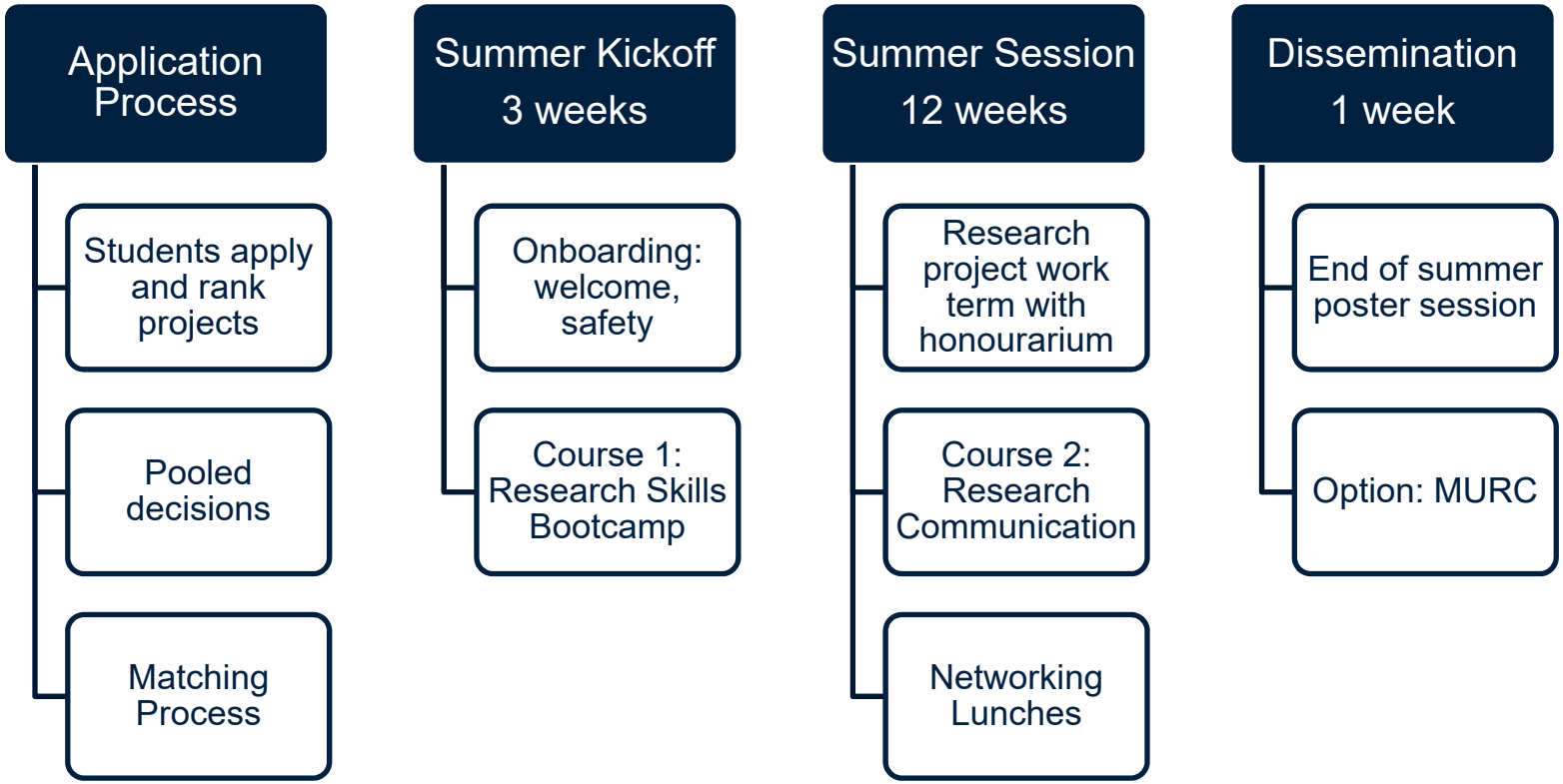
A supportive environment and cohort approach to research

Courses that complement and support your work

Counts as two* technical electives + Co-op!

Broad based entrance (minimum GPA 76% in 200-level +)

## WHAT CREATE-U LOOKS LIKE



## APPLY

November 15 – December 2

- 4 questions + unofficial transcript
- Project posting ranking

Minimum GPA - 76% average in 200-level and higher courses

Exception: GPA for students in Year 2 will include 100-level courses

What motivated you to apply for CREATE-U?

What is something you are (or have been) curious about? How have you explored this interest?

Describe a challenge you have faced - academically, professionally, or personally - and how you overcame it.

Describe a problem you had that did not have an obvious path to a solution. What did you do?

## POOLED DECISIONS

10 spots available for summer 2020

Broad-based admission – GPA is 1/6 of score

Looking for indicators of research potential

- Direct experience not necessary
- How you solve problems, technical or otherwise

## MATCHING PROCESS

Top applicant = 1st choice placement

2nd place applicant = 1st choice placement unless same as top applicant, then 2nd choice

etc.

After placements – informational interview

- Applicant or supervisor can decline if the match is a poor fit
- If first placement is a poor fit, applicant will be matched to one of the remaining projects

# MECH 410X RESEARCH SKILLS

Bootcamp format at start of summer - 3 hours / day for 3 weeks

By the end of this course, students should be able to:

- Explain how research is funded and disseminated
- Conduct a literature review
- Critically evaluate papers from the literature, including statistics
- Create a clearly defined and measurable research question
- Describe the purpose and structure of research conferences
- Explain how research structures (eg. funding, hiring) influence equity, diversity and inclusion (EDI) in research, and how this impacts the public

## SUMMER MAIN SESSION – 13 WEEKS – RESEARCH WORK TERM

30 hours / week for 13 weeks

$6000 compensation

Research lab in UBC Mech

Example positions at end of presentation

## MECH 410Y/550Y RESEARCH COMMUNICATION

By the end of this course, students will be able to communicate their research through a variety of genres, in a way that is understandable, relevant, and persuasive to audiences of varied backgrounds. Specifically, students will present their research in the following forms:

- Narrative literature review that builds on work done in MECH 410X
- NSERC Outline of proposed research
- Extended research abstract
- Poster presentation, which can then be presented at the Multi-disciplinary Undergraduate Research Conference (MURC)
- Academic journal article (for 500-level only*)

** Students going into 4th year who meet the Faculty of Graduate Studies requirements can take this course at the 500 level*

## NETWORKING LUNCHES AND MENTORSHIP

Graduate student mentor assigned to each student (typically working on the same or similar project)

Networking lunches for all students and mentors, and select faculty members

- Topics will vary
  - What a career in academia looks like
  - What an industry research career looks like
  - Communicating with your supervisor
  - What you do when you hit a research roadblock

## TIMELINE

- Apply!  November 15 – December 2
- Results Announced: January 6
- Informational interviews: early January
- CREATE-U Dates: May 4 – August 26, 2020
- + Poster Session (early September)
- MURC (optional): March 2021

# EXAMPLE POSITION DESCRIPTIONS

## EXAMPLE DESCRIPTIONS

- Wrist fracture fixation device
- Microscale soft pneumatic actuator
- Eye-tracked VR headset
- Investigating the human brain’s response to medical trauma
- Complex fluids experimental and computational simulation of oil & gas wells
- Data-driven modelling of materials and structures
- Development of a pressure bar for understanding high-strain rate behaviour of materials
- Development of a Directional Backlight Device for Use in Augmented Reality Head-up Displays
- Residual stress identification of double yield points in mild steel

# WRIST FRACTURE FIXATION DEVICE (1/2)

**The Project:**

Broken wrist fixation device for new surgical technique:

“To date, we have developed a couple of generations of the design and have verified that it can meet our accuracy goals. We now need to refine the design so that it can be tested first on cadavers and then on humans. We also need to refine it so that it could conceivably be manufactured in a cost-effective manner.”

**What You Will Do:**

Your task will be to iterate on the design and carry out the next round of testing – initially on a plastic model and subsequently on an animal and a cadaver specimen. Prototyping will likely be done using a combination of plastic and metal 3D printing. Ideally, you would also work with some software (largely pre-existing) to process the x-ray images and generate the device adjustment instructions.

# WRIST FRACTURE FIXATION DEVICE (2/2)

**Supervision Received:**

You will do this work in the Surgical Technologies Lab at the Centre for Hip Health and Mobility at VGH. Our group of about 10-12 graduate students has regular weekly meetings and most students will be working regularly at the lab throughout the summer. Dr. Hodgson works at the lab most days during the summer and maintains an open-door policy. The graduate student, Prash Pandey, is a PhD candidate and has extensive experience in related projects – he will be available for consultation on a near-daily basis.

**Skills for Success:**

Students should be generally familiar with solid modeling tools (eg, Solidworks or similar) and typical engineering programming languages (eg, Matlab or C/C++ or Python or similar).

# MICROSCALE SOFT PNEUMATIC ACTUATOR (1/2)

**The Project:**

This project is focused on developing a new soft material-based microscale actuator. The soft actuators are primarily used to perform various tasks such as gripping, surgical operations and locomotion… this project will investigate new designs that are capable of generating complex movements and non-uniform force distribution. Furthermore, this project will characterize the fabricated actuator and its input vs. performance relation.

**What You Will Do:**

The CREATE-U student will design and fabricate microscale pneumatic actuators. The student will validate the conceptual actuator (a sketch will be given) using SOLIDWORKS and COMSOL. Then a mold will be designed and fabricated (either using 3D printing or MEMS lithography). The final mold will be used in soft-lithographic techniques to fabricate the soft actuator. Finally, input vs. performance characteristics will be studied and different complex motions will be demonstrated.

# MICROSCALE SOFT PNEUMATIC ACTUATOR (2/2)

**Supervision Received:**

The day-to-day supervision will be carried out by the graduate student at the MEMS laboratory and the student will be meeting the faculty supervisor weekly. In case of unavailability, skype discussions will be arranged to clarify any issues related to the project. The student will gain the hands-on experience in designing, validating and fabricating of microscale soft actuators.

**Skills for Success:**

Experience in SOLIDWORKS and finite element analysis packages (not mandatory) will be advantageous.

# EYE-TRACKED VR HEAD SET (1/2)

**The Project:**

This project is focused to implement a new virtual reality (VR) head set compensating eye fatigue in VR gaming. The off-the-shelves Eye-Tracked VR Head Set (E-RVHS) currently being implemented in the MEMS laboratory will be used in this project. The primary goal of this project is packaging, fine tuning and testing of the E-RVHS. This technology is focused to be helpful in VR gaming, augmented reality platforms and dizziness diagnosing.

**What You Will Do:**

The CREATE-U student will fine-tune the E-RVHS and will do necessary packaging. Then E-RVHS will be interfacing with computers or VR platforms. This project will implement a program to read the electrode signals and head movement signals (accelerometers/gyroscopes). These signals will be combined in a program and will be used in the VR game to accommodate real-time control of camera coordinates. The CREATE-U student will also implement a small game using UNITY or Blender game engines to demonstrate the function of E-RVHS.

# EYE-TRACKED VR HEAD SET (2/2)

**Supervision Received:**

The day-to-day supervision will be carried out by the graduate student at the MEMS laboratory and the student will be meeting the faculty supervisor weekly basis. In case of unavailability,  skype discussions will be arranged to clarify any issues related to the project. The student will gain  hands-on experience in packaging, fine tuning, interfacing and VR related game programming.

**Skills for Success:**

The knowledge in basic programming such as C and Python will be required. Mechatronics specialization will be preferred. Previous experience in game development engines such as UNITY or Blender will be advantageous.

# INVESTIGATING THE HUMAN BRAIN'S RESPONSE TO MEDICAL TRAUMA (1/2)

**The Project:**

… in this project, we will use experimental and computational methods to determine mechanical inputs to the brain, and correlate with injury outcomes such as common concussion symptoms. A better understanding of this mechanism can lead to more timely diagnosis of injury and design of more effective protective equipment (e.g. helmets).

**What You Will Do:**

This is a flexible project where, based on the experience level and interests of the student, one or more of the following activities could be discussed:

- Building/applying physical brain models and acceleration devices to simulate brain mechanical deformations.
- Developing or applying computational brain models to simulate brain deformations.
- Instrumenting human participants with biomechanical and physiological sensors to measure the input head accelerations and output brain changes.
- Analysis of human participant data from sports and other head impacts scenarios.

# INVESTIGATING THE HUMAN BRAIN'S RESPONSE TO MEDICAL TRAUMA (2/2)

**Supervision Received:**

Weekly meetings with Dr. Wu (additional ad hoc meetings can be scheduled as needed); 2. More frequent interactions/consultations with grad student mentor as well as other graduate/undergraduate students in the lab; 3. Weekly lab meetings to communicate research with all members of the group.

**Skills for Success:**

Basic understanding of solid mechanics, materials, and dynamics (MECH2 level) required
Experience with Matlab, computational modeling software, inertial sensors, and Arduino-type circuits could be assets

# COMPLEX FLUIDS EXPERIMENTAL AND COMPUTATIONAL SIMULATION OF OIL & GAS WELLS (1/2)

**The Project:**

… Roughly 10-20% of wellbores leak, which reduces productivity, has health & safety consequences and environmental/ecological impact. This project will study this process from a fluid mechanics perspective… In the lab, we use two flow loops to simulate the field process. We have carefully designed and built the loops to achieve dynamic similarity. We can control the key parameters of the process, such as flow rate, eccentricity, rheology, and fluid's densities. The data acquisition is through imaging with high sensitivity cameras and automated instrumentation. The objective is to capture experimental data relevant to theoretical predictions of the fluid-fluid displacement flows under a wide variety of scenarios.

**Supervision Received:**

The graduate student mentor will support the student on a daily basis, as will another PhD student involved in the project. Professor Ian Frigaard will facilitate a number of group meetings.

# COMPLEX FLUIDS EXPERIMENTAL AND COMPUTATIONAL SIMULATION OF OIL & GAS WELLS (1/2)

**What You Will Do:**

The student will perform some combination of experimental work and associated computations, depending partly on interest and partly on needs of the team. Experimentally, the student will assist in all operations related with the experiment: fluid preparation, running experiment, image processing of the data, rheometry measurements of the fluids and data analysis. The student will learn the physical background to the experiments and may help in design of new components, undertake bits of machining/manufacturing, and implement changes to the current apparatus. Computationally, the student will run and analyse simulations for parameters selected to match with the experiments.

**Skills for Success:**

Active listening, communication, creative thinking, critical thinking, problem solving. Basic programming and machining skills. Interest in fluid mechanics.

# DATA DRIVEN MODELLING OF MATERIALS AND STRUCTURES (1/2)

**The Project:**

Data science is the extraction of information from large volumes of unstructured data… In this project, we seek to develop a data-driven modelling of materials and structures. The project will focus on developing data-based models to understand complex behavior of materials ranging from metallic materials to biomaterials. The expected outcome is the implementation of data-driven framework to predict energies and interactions that can be easily used by other users.

**What You Will Do:**

The successful candidate will develop a data-driven model to predict free-energy using data obtained from accurate models such as molecular dynamics and ab-initio calculations. The student will create/handle big data sets of information and use part of this information to develop a machine-learned potential that can accurately predict the collective behavior of materials.

# DATA DRIVEN MODELLING OF MATERIALS AND STRUCTURES (2/2)

**Supervision Received:**

The project will be carried out under the supervision of Prof. Mauricio Ponga and M.A.Sc. student Lucas Casparini. The supervision will be on daily basis as the project requires a well-defined time line. The student will meet weekly with the PI, and daily matters will be discussed with Mr. Casparini. The student will also have a mid-project presentation to report the progress of the project to the group, and a final presentation towards the end of the internship.

**Skills for Success:**

Intermediate C/C++ programming, Intermediate/Advance Python and Matlab (Machine Learning Toolbox). Good knowledge of coding techniques and data-compression skills will be an asset for the project.

# DEVELOPMENT OF A PRESSURE BAR FOR UNDERSTANDING HIGH-STRAIN RATE BEHAVIOUR OF MATERIALS (1/2)

## The Project:

The project is focuses on designing an apparatus to understand the high strain rate behavior of materials… This is important in many fields of engineering such as machining, impact applications and collisions of vehicles. The project focuses on developing a Pressure Bar to test materials, from the conceptual design to manufacturing and calibration of the device with amplifiers and strain gauges involving many areas of Mechanical Engineering. The device will be combined with high rate video cameras available in the Department to understand the failure of materials.

## What You Will Do:

The successful candidate will design, manufacture and calibrate the device from scratch. Due to the constrained timeline, the candidate should have a good background in machining of metals and use of strain gauge if possible. Selection of materials and profiles is required (for instance be familiar with McMaster Carr Catalogue). Once the device is built, the student will perform several tests on specimens made of steel, aluminum and magnesium, which are widely used in aerospace industry.

# DEVELOPMENT OF A PRESSURE BAR FOR UNDERSTANDING HIGH-STRAIN RATE BEHAVIOUR OF MATERIALS (2/2)

**Supervision Received:**

The project will be carried out under the supervision of Prof. Mauricio Ponga and Ph.D. student Mohamed Hendy. The supervision will be on daily basis as the project requires a well-defined time line. The student will meet weekly with the PI, and daily matters will be discussed with Mr. Hendy. The student will also have a mid-project presentation to report the progress of the project to the group, and a final presentation towards the end of the internship.

**Skills for Success:**

3D CAD design (SolidWorks or similar). Intermediate/Advance Machining of Metals (MECH training and proven machining skills). Good hands-on experience in machines and design. Analytical skills on mechanics of materials. Good use of electronics (amplifiers, strain gauges, welding, etc.) and instrumentation.

# DEVELOPMENT OF A DIRECTIONAL BACKLIGHT DEVICE FOR USE IN AUGMENTED REALITY HEAD-UP DISPLAYS (1/2)

**The Project:**

We are developing a waveguide-based backlight device using a microstructure array, which is directional and transparent. This device will be used as a light source in a head-up display for augmented reality applications.

**What You Will Do:**

The student will characterize the performance of the backlight device: the beam angle of the emitted light, the transparency, and the see-through image quality are to be measured. The backlight devices will be fabricated by Sam. A backlight device that meets the performance criteria will be assembled with the head-up display prototype, and the quality of the virtual image formed by the head-up display will also be evaluated by the student.

# DEVELOPMENT OF A DIRECTIONAL BACKLIGHT DEVICE FOR USE IN AUGMENTED REALITY HEAD-UP DISPLAYS (2/2)

**Supervision Received:**

Sam will be the student's day-to-day mentor. We will have a group meeting with Dr. Stoeber on a weekly basis.

**Skills for Success:**

We would like to see someone who has an interest in Augmented Reality, some knowledge in Optics (i.e. knows the lens equation), and a good mathematical background to begin with. Some scripting will be involved so an exposure to programming languages such as Python, Matlab, or C would be a good asset. If the student likes photography, it would be a bonus.

# RESIDUAL STRESS IDENTIFICATION OF DOUBLE YIELD POINTS IN MILD STEEL (1/3)

## The Project

The Slitting Method is an effective modern method for evaluating residual stresses. It involves measuring the deformations that occur during the progressive cutting of a slit through the material thickness. The residual stresses can then be evaluated from the deformation measurements. The research interest here has three main aspects:
1. confirmation that the double yield point phenomenon leaves its imprint within the loaded beam cross-section 2. demonstration of the capability of the slitting method to observe the double yield point phenomenon. 3. the measurements for the Slitting Method are typically done using strain gauges, and this approach will initially be used here. Subsequently, a new measurement approach is planned using Electronic Speckle Pattern Interferometry (ESPI). This is a full-field optical method and can give a much richer and potentially more informative data set. This use of ESPI is novel and would represent a substantial advance in the application of the Slitting Method.

# RESIDUAL STRESS IDENTIFICATION OF DOUBLE YIELD POINTS IN MILD STEEL (2/3)

## What You Will Do

1. Strain gauge a bending specimen, load it into the plastic region while measuring surface strains. Use an inverse calculation to infer the uniaxial stress-strain curve (hopefully demonstrating the double yield point).
2. Build an apparatus for doing slitting (using a three-axis motorized stage and motorized cutter). Write custom control software, likely in Matlab.
3. Use apparatus to do a Slitting Method measurement using strain gauges.
4. Use an inverse calculation to infer the residual stress cross-section (again hopefully demonstrating the double yield point).
5. If making really good progress, build an ESPI system for in-plane measurements on the Slitting Method specimen.
6. Use the apparatus to do a Slitting Method measurement using ESPI measurements. Do an inverse calculation to infer the residual stress cross-section (once again hopefully demonstrating the double yield point).
7. If all goes well, write a rather nice research paper.

# RESIDUAL STRESS IDENTIFICATION OF DOUBLE YIELD POINTS IN MILD STEEL (3/3)

**Supervision Received:**

The student(s) will work in a lab with professor and senior PhD student in a lab full of optics equipment and mechanical tools. The computational parts of the project will be very challenging and help will be available for this part. Guidance will be available for all other parts as well, although it is hoped that student will display substantial initiative and will work largely independently.

**Skills for Success:**

#1 is personal initiative and motivation. Working in a research lab is very much like working on a student team. You join the team because you want to be there and are really interested in what they do. You get on with the job without waiting to be told what to do. Success in this project will require good hand and brain skills, ability to write rather sophisticated Matlab code and to be able to think independently.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