This course provides an opportunity for students to work with a faculty member and carry out original research. Students will provide assistance with one of the faculty member's research projects, while also earning credit. Students will gain first-hand exposure to current research methods, and share in the excitement of discovery of knowledge acquisition. Progress will be monitored by regular meetings with the faculty member and through a reflective journal. Final results will be presented in a written report and/or a presentation at the end of the term. Approximately 120 hours of work is expected for the course.

**Prerequisite:** Permission of the Course Coordinator (Dr. Kris Kim, kris.kim@utoronto.ca)

**Recommended Preparation:** Completion of at least 4.0 credits in a relevant discipline.

**Breadth Requirements:** Natural Sciences

**Link to UTSC Timetable:** [https://utsc.calendar.utoronto.ca/section/physical-sciences](https://utsc.calendar.utoronto.ca/section/physical-sciences)

**Note:** Students must send an application to the course coordinator (Dr. Kris Kim, kris.kim@utoronto.ca) for admission into this course. Applications must be received by **December 18th for Winter enrolment.** Typically, students enrolled in a program offered by the Department of Physical and Environmental Sciences and students who have a CGPA of at least 2.5 or higher are granted admission. Approved students will receive a supervised study form to be submitted to the Office of the Registrar. Students are strongly encouraged to reach out to potential supervisors in advance of the deadline above.

**Applications must include:**

1) A letter of intent indicating the student's wish to enroll in the course
2) A list of preferred projects, ranked in order of preference (see project descriptions below)
3) A list of relevant courses successfully completed by the student, as well as any relevant courses to be taken during the upcoming semester

*Please see below for list of projects.*
Environmental Sciences Projects

Project 1 (Environmental Science)

Supervisor: Prof. Karen Smith (karen.smith@utoronto.ca)

Title: Visualizing Climate and Weather Extremes in Canada

Project Description:
Climate change is having an impact on regional climate and weather extremes across Canada including heat waves, floods, fires and sea-level rise. Students involved in this project will work with their supervisor to research and identify weather and climate extremes in Canada based on the peer-reviewed literature, reports and news media. Students will then utilize the ERSI StoryMap software to map climate and weather extremes in Canada, creating an interactive, educational tool to support climate courses in DPES.

Qualifications: EESB03

Project 2 (Environmental Science)

Supervisor: Prof. Élyse Caron-Beaudoin (elyse.caronbeaudoin@utoronto.ca)

Title: Systematic review on the health effects associated with exposure to hydraulic fracturing

Project Description:
Hydraulic fracturing is an industrial process used to extract natural gas and other fossil fuels energy. The process involves drilling a well vertically for up to 4 kilometers, and then horizontally for up to another 3 kilometers. Large amounts of water, sand, and chemicals are injected under high pressure into the rock, fracturing it to release gas.

Most of British Columbia’s natural gas is extracted using hydraulic fracturing in the Northeastern region. The main objective of our research project is to undertake a systematic review of studies examining the effects of hydraulic fracturing on human health. Specifically, we evaluate epidemiological and toxicological studies in order to assess the impact of proximity to hydraulic fracturing activities on the physical health of human populations. Our research team includes physicians and citizens of Northeastern British Columbia, as well as researchers based at the University of Toronto, the University of British Columbia, the Simon Fraser University and the Center for Clinical Epidemiology & Evaluation in Vancouver.

The student will be responsible for the data extraction from selected toxicological studies using the HAWC software. The student will also be implicated in the results interpretation and the writing of a manuscript.

Qualifications: EESA10H3 with a minimum grade of B+
Chemistry Projects

Project 1 (Chemistry)
Title: Developing New Experiments for CHMB41H
Supervisor: Prof. Shadi Dalili (sh.dalili@utoronto.ca)
Project Description:
Students involved in this project will be able to develop and modify new laboratory experiments for Introductory Organic Chemistry I (CHMB41H). Students in this placement will work with the course instructor to select new experiments from the chemistry education literature, test the experiments, and prepare accompanying lab manual pages and demonstrator notes. Students will learn skills such as literature searching and analysis, and utilize essential lab techniques such as extraction, distillation, recrystallization, reflux, etc. to develop new labs for the course. Students will also develop written scientific and communication skills through developing lab manual writeups, quizzes, and TA documents for each experiment developed.
(Students Required: 1-2 positions)

Qualifications: Completion of CHMB42 with a minimum course grade of B+ and lab grade of A-; must be available for lab work 2 full days during the week between 9am-5pm, ideally Tues, Thurs, or Fri. Please send updated resume and transcript to sh.dalili@utoronto.ca

Project 2 (Chemistry)
Title: Developing New Tutorial Material for CHMB41H
Supervisor: Prof. Shadi Dalili (sh.dalili@utoronto.ca)
Project Description:
Students involved in this project will be expected to develop new tutorial worksheets and quizzes based on current CHMB41H course content, using reputable scientific resources and textbooks. Students in this placement will work with the course instructor to select and develop appropriate questions and exercises from the chemistry education literature, textbooks, and online resources to prepare tutorial material and quizzes, along with demonstrator notes. Students will learn skills such as literature searching and analysis, and proper design of problem sets and questionnaires. Students will also develop written scientific and communication skills through developing problem sets, quizzes, and TA documents for each tutorial section.
(Students Required: 1-2 positions)

Qualifications: Completion of CHMB42 with a minimum course grade of B+. Please send updated resume and transcript to sh.dalili@utoronto.ca
Project 3 (Chemistry)

Title: Lab Development Assistant for the New CHMA12H3 General Chemistry Course

Supervisor: Prof. Lana Mikhaylichenko (lana.mikhaylichenko@utoronto.ca)

Project Description:
Students involved in this project will perform literature search for the new laboratory experiments for the new General Chemistry II CHMA12H3 course. Each experiment will be evaluated on relevance to the course material, price, and level of difficulty. Most promising experiments will be performed in a lab. Students will participate in preparation of the practical part of each experiment as well as prepare sets of potential quiz questions. The working schedule will be built based on the current situation and students’ availability. This project required participation in performing selected experiments in person.

Qualifications: Completion of either CHMC47 or minimum CHMB42 with a minimum grade of B+.

Project 4 (Chemistry)

Title: Quantum computing for quantum chemistry

Supervisor: Prof. Artur Izmaylov (artur.izmaylov@utoronto.ca)

Project Description:
In my group we develop methods for the electronic structure and quantum dynamics of molecules using a new emerging technology of quantum computing. There is a variety of problems related to finding efficient algorithms for quantum chemistry problems to be performed on currently available quantum computers. For further information please see our recent publications on the Prof. Izmaylov Google scholar page and contact me directly.

Project 5 (Chemistry)

Title: Lithium ion battery material development

Supervisor: Prof. Oleksandr Voznyy (o.voznyy@utoronto.ca)

Project Description:
Our group focuses on developing next generation lithium-ion battery materials. This project aims at exploring novel battery electrode materials. The project will mainly involve literature search, material synthesis, coin cell battery assembles and testing. Students could also be exposed to machine learning and theoretical computations. Students will learn electrochemistry and material science knowledge. Students will work on this project led by the PhD student. This project requires in-person lab experiments.

Qualifications: Completion of CHMA10, CHMA11, and CHMB16 with minimum grade of B+.
Project 6 (Chemistry)
Title: Electrochemical synthesis of ammonia
Supervisor: Prof. Oleksandr Voznyy (o.voznyy@utoronto.ca)
Project Description:
Our group is interested in electrochemical reduction of nitrogen gas into ammonia in water. The project will mainly involve electrochemistry testing of catalysts, optimizing electrochemical reactors, NMR analysis. Students could also be exposed to theoretical computations. Students will learn electrochemistry, material science, and chemical engineering knowledge. Students will work on this project led by the PhD student. This project requires in-person lab experiments.

Qualifications: Completion of CHMA10, CHMA11, and CHMB16 with minimum grade of B+.

Project 7 (Chemistry)
Title: Developing New Experiments for First Year Chemistry (CHMA11)
Supervisor: Prof. Kris Kim (kris.kim@utoronto.ca)
Project Description:
The past several months has been a time of rapid change and adjustment as we continue to engage in remote learning opportunities. Students will work with the course instructor to design, test, and build resources towards creating sustainable virtual exercises for first-year chemistry. Through this process, students will develop their ability to search the literature for relevant experiments and techniques, design, test, and modify experimental procedures, and learn to apply principles of instructional design and best practices for effectively engaging learners through online platforms. This project will require some in-person components.

Qualifications: Completion of CHMA10 and CHMA11 with a minimum course grade of B+. Please send updated resume and transcript to kris.kim@utoronto.ca.

Project 8 (Chemistry)
Title: Developing New Experiments for Analytical Chemistry (CHMB16)
Supervisor: Prof. Kris Kim (kris.kim@utoronto.ca)
Project Description:
Students in this placement will work with the course instructor to design, test, and build resources towards creating sustainable virtual exercises for second-year analytical chemistry (CHMB16). Through this process, students will develop their ability to reflect on prior first- and second-year chemistry learning outcomes, search the literature for relevant experiments, design, test, and modify experimental procedures, and learn to apply principles of instructional design and best practices for effectively engaging learners through online platforms. This project will require some in-person components.

Qualifications: Completion of CHMB16 with a minimum course grade of B+. Please send updated resume and transcript to kris.kim@utoronto.ca.