PSCB90H3 Physical Sciences Research Experience – Summer 2020


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. Effie Sauer, effie.sauer@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

Note: Students must send an application to the course Coordinator (Dr. Effie Sauer, effie.sauer@utoronto.ca) for admission into this course. Applications must be received by the end of August for Fall enrolment, December 15th for Winter enrolment, and **April 30th for Summer 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 signed course enrolment form to be submitted to the Office of the Registrar.

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

Project 1 (Chemistry)

Supervisor: Prof. Shadi Dalili (sdalili@utsc.utoronto.ca)

Title: Developing New Tutorial Material for CHMB41H

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 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.

Qualifications: Completion of CHMB42 with a minimum course grade of B+.

Project 2 (Chemistry)

Supervisor: Prof. Kris Kim (kris.kim@utoronto.ca)

Title: Development of online and DIY CHMA11 experiments

Project Description: With rapid advancements in learning management systems and online classroom platforms, distance learning is becoming more popular for both learners and teachers. While many are successfully moving traditional lecture-based curricula in an online format, whether that would be delivering real-time or pre-recorded lectures to facilitating online assignments and tests, moving chemistry lab experiments online that require wet-lab spaces becomes more challenging. Students in this placement will work with the course instructor to design, test, and build resources towards creating online, or "do-it-yourself" (DIY), first year chemistry experiments. Through this process, students will develop their ability to search the literature for relevant experiments and techniques, test and modify experimental procedures, and learn to apply principles of instructional design and best practices for effectively engaging learners through e-learning environments.

Qualifications: Completion of CHMA10 and CHMA11 with a minimum course grade of B+

Project 3 (Chemistry)

Supervisor: Prof. Lana Mikhaylichenko (mikhay@utsc.utoronto.ca)

Title: Lab Development Assistant for C-level Organic Chemistry Courses and New CHMA11H3 General Chemistry Course

Project Description: Students involved in this project will perform literature search for the new laboratory experiments for the Bio-Organic and Organic Chemistry Mechanisms courses and 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. It is likely that all practical work will be done after the summer reading week.

Qualifications: Completion of either CHMC47 or CHMC41/42 with a minimum grade of B+.

Project 4 (Chemistry)

Supervisor: Prof. Nirusha Thavarajah (nirusha.thavarajah@utoronto.ca)

Title: Writing a Review Article on Technology Integrated Pedagogical Tools in Chemical Education

Project Description: Students will explore the literature on technology integrated pedagogical tools in chemical education. Students will study the impact measures of most effective & modern pedagogical tools in chemical education and will develop an educational research paper under the instructor's supervision. Students will use resources from the library, Centre for Teaching and Learning (CTL), and writing centre to help with their research, critical analysis, and selecting suitable literature to write their manuscript for publication on Journal of Chemical Education.

Qualifications: Completion of 3rd year chemistry in organic, analytical and/or inorganic courses, with at least B+ average.

Project 5 (Chemistry)

Supervisor: Prof. Nirusha Thavarajah (nirusha.thavarajah@utoronto.ca)

Title: Developing New Tutorial and Lab Materials for CHMA11H3 & CHMB41H3

Project Description: Students will develop new tutorial and lab materials based on the existing CHMA11H3 & CHMB41H3 content, textbooks and other reliable scientific resources. Students will work with the instructor to develop tutorial work sheets, tutorial quizzes, lab demo notes and lab quizzes.

Qualifications: Completion of CHMB42H3 with a minimum grade of B+.

Project 6 (Chemistry)

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

Title: Machine learning assisted search for new materials for Li-ion batteries and light-emitting diodes

Project Description: Solid-state electrolytes promise to improve battery safety as well as increase the charging speed. There is only a handful of materials with known good ionic conductivity and a broader screening is urgently needed. We plan to employ machine learning approaches, in particular, one-shot learning and transfer learning, to predict ionic conductivity for a database of 1 mln materials without the need for computationally expensive quantum chemistry methods.

The student will develop a representation of the features to encode the material structural and chemical information, write a program for training the machine learning algorithm to predict the stability and bandgap of materials as available in online databases (Materials Project), collect experimental data about ionic conductivity from literature and calculate same properties using quantum chemistry approaches, in order to apply transfer learning techniques to predict ionic conductivity.

Project 7 (Environmental Chemistry)

Supervisor: Prof. Tanzina Mohsin (tanzina.mohsin@utoronto.ca)

Title: Climate Change Impact Assessment

Project Description: Scientific evidences for warming of the climate system are clear. Although attempts have been made to tackle the climate change, warming due to anthropogenic emissions of greenhouse

gases will continue over the next two or three decades. This will continue to cause impacts on human system including infrastructure, industry and natural resources. Therefore, countries, regions and cities will have to adapt to the changes that are already underway. A part of the solution to this problem is to provide climate information in formats tailored to fit into the planning and design decisions of a variety of industries and for different sectors of the society, which can be a baseline for making defensible climate change decisions. The Climate Change Hazard Information Portal (CCHIP) is an impact assessment tool which gives outputs of the climate models in such a way that is valuable to everyday decision makers. A student intends to work on an impact assessment study will learn how to use the CCHIP tool to analyze impacts on climate change in an area of interest. Some examples of projects are impact of climate change on extremes weather events causing flooding in cities, impact of climate change on production of wine grapes affecting the wine industries in Niagara Peninsula, or impact of climate change on occurrences of forest fire in vulnerable locations in British Columbia. A student can also propose a project of his/her interest and can be approved if it is workable within the CCHIP.

Qualifications: Completion of EESB03 or its equivalent.