Supervisor: **Andrew Lewis**  
**Project Title:** Computer algebra explorations of controllability  
**Open to (expected background/level of study):** Student will have completed third year in MathEng or Honours Arts & Science  
**Project description:** Controllability is a central problem in control theory, and for nonlinear systems is one of the outstanding unresolved problems in the subject area. The matter of determining conditions, be they necessary or sufficient, for controllability is a challenging problem. In this work, various ideas for exploring controllability conditions will be tested. The idea is to work with some challenging examples in the literature, some understood and some not, and see whether some light can be shed on these by new ideas of the supervisor.  
**Student role:** Design and implement computer algebra code for controllability.

Supervisor: **Fady Alajaji**  
**Project Title:** Error-Control Codes for Channels with Memory  
**Open to (expected background/level of study):** Students at the end of their third or fourth year of studies.  
**Project description:** We will investigate the optimization of decentralized stochastic control systems and study rigorous approximation methods obtained through the quantization of measurement and control action variables. The project will include material from probability, control theory, real analysis, and possibly information theory.  
**Student role:** The student will be involved in all aspects of the project, including a thorough literature review and a meticulous understanding of the state-of-the-art results, mathematical derivations, performance analysis, performing numerical simulations and writing a detailed research report.

Supervisor: **Fady Alajaji**  
**Project Title:** Coding Strategies for Two-Way Source-Channel Systems  
**Open to (expected background/level of study):** Students at the end of their third or fourth year of studies.  
**Project description:** This project will explore source-channel coding strategies for the reliable transmission of (discrete and analog valued) information sources over two-way noisy communication networks, in which the users simultaneously transmit and receive information. The derivation of optimal encoding/decoding functions under different distortion criteria will be examined. In particular, one objective is to elucidate the network conditions under which linear coding strategies are optimal.
Student role: The student will be involved in all aspects of the project, including a thorough literature review and a meticulous understanding of the state-of-the-art results, mathematical derivations, performance analysis, performing numerical simulations and writing a detailed research report.

Supervisor: Devon Lin, Glen Takahara and David Thomson
Project Title: TBA
Open to (expected background/level of study):
Project description:
Student role:

The following project is being offered by Mohan Chaudhry of the Department of Mathematics and Computer Science at the Royal Military College of Canada. Students interested in applying for this project should contact Dr. Chaudhry directly.

Project Title: Inverting transforms that arise in the study of Markov models
Project description: Many of the analytic solutions in queueing and other stochastic processes are derived in various transforms such as probability generating functions and Laplace transforms. The problems become more complicated if there are unknowns in the transforms. Several complicated algorithms/methods have been proposed to invert such transforms. We have developed a software program which inverts such transforms using the roots of high degree polynomials and transcendental functions. Our method of inverting such transforms is much more efficient and fast when compared with other methods.
Student role: The student's role will be to invert such transforms using mathematical tools such as MAPLE/MATLAB or MATHEMATICA and QROOT, a software developed by us as well as do some mathematical typing.