

**Queen's University at Kingston  
Department of Mathematics and Statistics**

**SUMMER 2012 NSERC USRA Research Projects**

**Last updated: [6 February 2012](#)**

Applicants are encouraged to contact prospective research supervisors to discuss research projects prior to filing an application.

*You are also advised to check back frequently for new/updated projects.*

**Supervisor:** [Fady Alajaji](#)

**Work term:** May-August 2012

**Title:** Bounding the Probability of a Finite Union of Events

**Project description:** This project concerns the study of bounding the probability of a finite union of events when only the individual and pairwise event probabilities are known a priori. A systematic literature review of the sharpest upper and lower bounds will be first conducted. The derivation of new bounds as well as extending existing ones will be next examined. Finally, if time permits, applications to the error analysis of communication systems will be considered.

**Supervisor:** [Fady Alajaji](#)

**Work term:** May-August 2012

**Title:** Error Analysis for Multihypothesis Testing under Markovian Noise

**Project description:** This project focuses on analyzing the minimum error probability when testing multiple hypotheses corrupted by Markovian noise. The Poor-Verdu lower bound for the minimum error probability as well as its recent extension will be adopted to this problem. Applications to the sequence maximum a posteriori decoding of uncoded raw data sent over wireless communication channels modeled via binary additive noise channels with memory will also be examined.

**Supervisor:** [Fady Alajaji](#)

**Work term:** May-August 2012

**Title:** Data Compression via Error Correcting Codes

**Project description:** The objective of this project is to investigate the use of algebraic error correcting codes for the purpose of lossy and lossless data compression and explore the operational duality between source and channel coding. Specifically, linear channel block codes will be analyzed and converted into compression codes. A performance study in terms of compression efficiency and system distortion will also be conducted.

**Supervisor:** [Devon Lin](#)

**Work term:** May-August 2012

**Title:** Obtaining fractional factorial designs of variable resolution

**Project description:** Prior or background knowledge may suggest that interactions arise only within certain factors. When such knowledge is available, Lin (2012) proposed a

new class of designs called fractional factorial designs of variable resolution. This projects apply an optimization algorithm to searching for optimal fractional factorial designs of variable resolution based on various criteria such as generalized minimum aberration.

**Supervisor:** [Tamas Linder](#)

**Work term:** May-August 2012

**Title:** Statistical Learning Theory

**Project description:** tba

**Supervisor:** [Jamie Mingo](#)

**Work term:** May-August 2012

**Title:** A Combinatorial Interpretation of the Mellin Transform

**Project description:** An important transform in mathematics is the Fourier transform. In probability theory it is the logarithm of the Fourier transform that is more important; for it relates the moments of a random variable to its cumulants (higher order versions of the variance and skewness). Moreover this correspondence has a simple interpretation in terms of set partitions. Cumulants have been used in statistics for a long time because they linearize the sum of independent random variables.

The Mellin transform does the same for the product of independent random variables, but no combinatorial interpretation is known. By following an analogy in free probability we shall investigate this using Fock space.

The project requires a course in linear algebra and a basic course in probability.

**Supervisor:** [Ram Murty](#)

**Work term:** May-August 2012

**Title:** Problems in the Theory of Modular Forms

**Project description:** Fourier coefficients of modular forms and modular functions are ubiquitous in mathematics. Their arithmetic and analytic nature have been the focus of intense research for more than a century. The summer project will focus on various unresolved questions in this context. More precisely, we will study recent developments giving algebraic connections to these Fourier coefficients and explore the world of "mock modular forms".

**Supervisor:** [Greg Smith](#)

**Work term:** May-August 2012

**Title:** Experiments with Monomial Ideals

**Project description:** Monomial ideals, with their close connections to combinatorial objects, serve as an excellent test bed for general theories in commutative algebra and algebraic geometry. The basic aim of this project is to use computer algebra to experimentally investigate various properties of monomial ideals. We will start by examining conjectures of Harbourne and Huneke that compare the symbolic power of an ideal with the regular power of an ideal. Preference will given applicants with a strong background in algebra and some programming experience.

**Supervisor:** [Serdar Yuksel](#)

**Work term:** May-August 2012

**Title:** Mathematics of Networked Control Systems

**Project description:** We will investigate design, stabilization and optimization of stochastic networked control systems.