**CALENDAR**

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Time</th>
<th>Place</th>
<th>Speaker</th>
<th>Title</th>
<th>Abstract Attached</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wednesday, March 23</td>
<td>Curves Seminar</td>
<td>3:00 pm</td>
<td>Jeffery 319</td>
<td>Mike Roth</td>
<td>Bogomolov Instability</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thursday, March 24</td>
<td>Math Club</td>
<td>5:30 p.m.</td>
<td>Jeffery 118</td>
<td>Gregory G. Smith</td>
<td>Finding roots of polynomials with differential</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>equations</td>
<td></td>
</tr>
<tr>
<td>Friday, March 25</td>
<td>Good Friday</td>
<td></td>
<td></td>
<td></td>
<td>University offices are closed.</td>
<td></td>
</tr>
<tr>
<td>Wednesday, March 30</td>
<td>Conference Room</td>
<td>1:00 p.m.</td>
<td>Jeffery 521</td>
<td>Akshaa Vatwani</td>
<td>Higher Rank Sieves and Applications</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thursday, March 31</td>
<td>Special Lecture</td>
<td>2:30 p.m.</td>
<td>Jeffery 234</td>
<td>Yitang Zhang, University of</td>
<td>General divisor functions in arithmetic</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>California, Santa Barbara,</td>
<td>progressions to large moduli</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M. Ram Murty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friday, April 1</td>
<td>Graduate Seminar</td>
<td>12:30 p.m.</td>
<td>Jeffery 319</td>
<td>Josue Vazquez</td>
<td>Algebraic Probability Independences as a</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Universal Products</td>
<td></td>
</tr>
<tr>
<td>Friday, April 1</td>
<td>Department Colloquium</td>
<td>2:30 p.m.</td>
<td>Jeffery 234</td>
<td>Vojin Jurdjevic, University</td>
<td>Jacobi’s Geodesic Problem and Integrable</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>of Toronto</td>
<td>Hamiltonian Systems on Lie Algebras</td>
<td></td>
</tr>
</tbody>
</table>

Items for the Info Sheet should reach Anne (burnsa@mast.queensu.ca) by noon on Monday. The Info Sheet is published every Tuesday.

**Wednesday, March 23, 3:00 p.m. Jeffery 319**

**Curves Seminar**

**Speaker:** Mike Roth  
**Title:** Bogomolov Instability  
  
**Abstract:** We will discuss Bogomolov’s theorem for rank two vector bundles on a surface.

**Thursday, March 23, 5:30 p.m. Jeffery 118**

**Math Club**

**Speaker:** Gregory G. Smith  
**Title:** Finding roots of polynomials with differential equations  
  
**Abstract:** How do the roots of a polynomial depend on its coefficients? In this talk, we will explore this problem by looking for explicit formulae. To accomplish this, we will exploit certain hypergeometric differential equations and power series.
Thursday, March 31, 2:30 p.m. Jeffery 234
Speaker: Yitang Zhang
Title: General divisor functions in arithmetic progressions to large moduli

Abstract:

A classical method of analytic number theory shows that, for a fairly large class of arithmetic functions $f$,

\[
\sum_{d \leq x^\vartheta} \max_{(a,d)=1} \left| \sum_{\substack{n \leq x \mod d}} f(n) - \frac{1}{\varphi(d)} \sum_{\substack{n \leq x \mod (n,d)=1}} f(n) \right| \ll \frac{x}{(\log x)^A} \tag{1}
\]

with $\vartheta = 1/2 - \varepsilon$, where $\varphi(d)$ is the Euler function, and where $A$ is an arbitrarily large constant. With $f = \Lambda$, the von Mangoldt function, (1) is a somewhat weaker form of the celebrated Bombieri-Vinogradov theorem. It is believed that (1) is valid with $\vartheta = 1 - \varepsilon$ for many $f$. However, if $\vartheta$ is (slightly) greater than $1/2$, even the weaker estimate

\[
\sum_{d \leq x^\vartheta} \left| \sum_{\substack{n \leq x \mod d}} f(n) - \frac{1}{\varphi(d)} \sum_{\substack{n \leq x \mod (n,d)=1}} f(n) \right| \ll \frac{x}{(\log x)^A}, \tag{2}
\]

where $a \neq 0$ is fixed, seems quite difficult to prove. For example, with $f = \tau_k$, the $k$-fold divisor function, (1) can be proved for some $\vartheta > 1/2$ only if $k = 2$ or $3$.

In the work of the author on the bounded gaps between primes, a crucial step is an estimate of type (2) for some $\vartheta > 1/2$, with $f = \Lambda$ and with a constraint imposed on the modulo $d$ (in fact a somewhat more general form is dealt with). The proof contains combinatorial arguments, the dispersion method and bounds for Kloosterman sums. Recently it was realized that, with a similar constraint on $d$, our method also applies to the case $f = \tau_k$ for any $k$. Thus we are able to establish an estimate of the form

\[
\sum_{d \leq x^\vartheta} \left| \sum_{\substack{n \leq x \mod d}} \tau_k(n) - \frac{1}{\varphi(d)} \sum_{\substack{n \leq x \mod (n,d)=1}} \tau_k(n) \right| \ll \frac{x}{(\log x)^A} \tag{3}
\]

for any $k$, where $\vartheta$ is a constant greater than $1/2$ and independent of $k$. The set $D$ is to be specified in the talk. In fact, bounds sharper than the right-hand side of (3) are possible.

Professor Yitang Zhang is well-known for his path-breaking work showing the infinitude of bounded gaps between prime numbers. His work has led to a flurry of activity on the twin prime problem and the talk will be a colloquium style presentation of recent developments. He is the recipient of the Cole Prize, Ostrowski Prize, Rolf Schock Prize and holds a MacArthur Fellowship.

Friday, April 1, 12:30 p.m. Jeffery 319
Speaker: Josue Vazquez
Title: algebraic Probability Independences as a Universal Products

Abstract: We first introduce the concepts of an algebraic probability space and the algebraic distribution of its elements. Then we define different notions of independence were the main idea is that two elements in an algebraic probability space are independent if their joint distribution is completely determined by the individual distributions. This leads us to consider universal products to classify such notions of independence. Then we show that not only classical independence can be recovered under
This algebraic perspective but also the existence of more independences, being free independence one of the most developed and studied notions of algebraic independence.

This talk is based on the paper "On Universal Products" by Roland Speicher.

**Friday, April 1, 2:30 p.m. Jeffery 234**

**Speaker:** Velimir Jurdjevic

**Department Colloquium**

**Title:** Jacobi’s Geodesic Problem and Integrable Hamiltonian Systems on Lie Algebras

**Abstract.** This lecture will introduce an affine-quadratic optimal control problem on a Lie group $G$ with a semi-simple Lie algebra $\mathfrak{g}$ that admits Cartan decomposition $\mathfrak{g} = \mathfrak{p} + \mathfrak{t}$ subject to the usual Lie algebraic conditions

$$[\mathfrak{p}, \mathfrak{p}] \subseteq \mathfrak{t}, \quad [\mathfrak{p}, \mathfrak{t}] \subseteq \mathfrak{p}, \quad [\mathfrak{t}, \mathfrak{t}] \subseteq \mathfrak{t}. $$

We will find the necessary and sufficient conditions that the associated Hamiltonian

$$H = \frac{1}{2} (Q^{-1}(L_t), L_t) + (A, L_p),$$

where $\langle , \rangle$ denotes the Killing form, $Q : t \rightarrow t$ is a positive definite operator, and $A$ is a regular element in $\mathfrak{p}$ admits an isospectral representation of the form

$$\frac{dL_\lambda}{dt} = [M_\lambda, L_\lambda],$$

$$M_\lambda = Q^{-1}(L_\lambda) - \lambda A, \quad L_\lambda = -L_p + \lambda L_t + (\lambda^2 - 1)B,$$

for some element $B \in \mathfrak{p}$. Then we will correlate these findings with the seminal works of S.M. Manakov, A.T. Fomenko, A.S. Mishchenko, V.V. Trofimov and O. Bogoyavlensky on the integrability of the $n$-dimensional mechanical tops.

Additionally, we will single out an affine-quadratic Hamiltonian whose spectral invariants lead to the integrals of motion for the Jacobi’s geodesic problem on the ellipsoid. More explicitly, we will link Jacobi’s problem with the elliptic geodesic problem on the sphere and we will be able to show that the elliptic problem on the sphere and C. Newmann’s mechanical problem on the sphere share the same integrals of motion inherited from the affine Hamiltonian on the Lie algebra of matrices of zero trace.