Undergraduate Activities at MMW 2015

As part of the undergraduate program at the Modern Math Workshop, each student attends one of the two mini-courses presented on ***Wed., Oct. 28, 1-5pm****:*

1) Harshad Numbers and Sage Programming

A Harshad number is a positive integer that is divisible by the sum of its digits. The word "Harshad" comes from the Sanskrit harsa (joy) + da (give), meaning joy-giver, which was defined by the Indian mathematician D.R. Kaprekar. All one digit numbers are Harshad numbers and it is fairly simple to determine which two digit numbers are Harshad. In 1994, H. Grundman generalized the concept to *b*-Harshad (or *b*-Niven) numbers. Simply put, for b > 1, a *b*-Harshad number is a positive integer that is divisible by the sum of the digits of its base *b* expansion. The mini-course will provide undergraduate students with an opportunity to learn about Harshad numbers and how to compute some of their properties using the freely available mathematical program Sage. No prior programing experience is required.

Prerequisite: An undergraduate algebra or number theory course.

Organizers: **Alejandra Alvarado** is an Assistant Professor at Eastern Illinois University. Her research interests are in number theory and Diophantine equations. She received her PhD from Arizona State University under the supervision of Dr. Andrew Bremner. In her spare time she enjoys running.

Helen G. Grundman is a Professor of Mathematics at Bryn Mawr College. She received her PhD from the University of California, Berkeley, held a C.L.E. Moore Instructorship at MIT, a Postdoctoral Research Fellowship at MSRI, a Science Fellowship at the Bunting Institute of Radcliffe College, and the Rosalyn R. Schwartz Lectureship at Bryn Mawr College. Last year, she was awarded the Christian R. and Mary F. Lindback Award for Distinguished Teaching. Her research areas include algebraic number fields, Hilbert modular varieties, Galois realizability, elementary number theory, modular forms, and computational number theory. Her teaching ranges from courses for math-phobic undergraduates through graduate level courses in algebra and mathematics pedagogy. She has supervised over 30 student research projects at levels ranging from sophomore undergraduate through PhD.

Pamela E. Harris is a Mexican-American Davies Research Fellow of the National Research Council with a dual appointment at the United States Military Academy (West Point, NY) and the Army Research Lab (Adelphi, MD). She will join the faculty of Williams College in the fall of 2016. Dr. Harris received her PhD from the University of Wisconsin at Milwaukee in May 2012 under the supervision of Dr. Jeb Willenbring. Her research interests focus on combinatorial problems related to the representation theory of Lie algebras and more recently she has begun work on problems in analytic number theory, image processing, and mathematical biology. Dr. Harris is firmly dedicated to improving diversity and retention rates among women and minorities in the mathematical sciences. As part of her outreach, she commits time to organizing scientific symposia during the national SACNAS conference and is a member of the organizing committee for the Infinite Possibilities Conference.

2) An Introduction to the Theory of Sandpiles

The sandpile model developed by Bak, Tang, and Wiesenfeld in 1987 is a mathematical model first used to exemplify the concept of self-organized criticality (SOC). SOC is a property of certain dynamical systems that naturally evolve toward critical states and it is considered to be one of the mechanisms by which complexity arises in nature. The abelian sandpile model

introduced by Dhar in 1990 is a special class of sandpile model defined on a combinatorial graph whose dynamic structure is encoded in a finite abelian group known as the sandpile group. This algebraic structure has played a central role in the study of diverse properties of the abelian sandpile model. Moreover, the sandpile group has also been an important object of study in several distinct areas of mathematics, including algebraic combinatorics, algebraic, tropical and arithmetic geometry, the theory of computation, and the study of pattern formation.

In this mini-course, we will give an introduction to the theory of sandpiles. In particular, we will study the interactions between the combinatorics of the graph, the algebraic information of the sandpile group and the dynamics of the abelian sandpile model.

Prerequisite: One undergraduate course in linear algebra.

Organizer: **Luis David Garcia-Puente** is an Associate Professor of Mathematics at Sam Houston State University. He received his B.S. in Mathematics degree from the *Universidad Nacional Autonoma de Mexico* in 1999 and his Ph.D. in Mathematics from Virginia Tech in 2004. He has held postdoc appointments at the Mathematical Sciences Research Institute and at Texas A&M University. His work focuses on computational algebraic geometry and its applications. He has been involved in Research Experience with Undergraduate programs in Mathematics for 15 years and several resulting projects have culminated in award-winning student presentations or joint research publications. When he is not at work, he enjoys playing board games with his daughters or spending time in a racquetball court. He used to be known as a good salsa dancer, but those days are long gone.