SPECIAL SUMMER MATHEMATICS
COLLOQUIUM SERIES
2019 REU MATHEMATICS PROGRAM

Note: All talks will take place in room EMCS 422.

Thursday, August 1

9:45 – 10:00  Welcoming Remarks
Joe Wilferth, Interim Dean
College of Arts and Sciences

10:00 – 10:30  Emily Eckels, Steven Jin, and Brian Tobin
Lower Bounds for the $L^1$ Norm of Exponential Sums

10:40 – 11:10  Margaret Brown and Shan (Miko) Jiang
Modeling Cholera Transmission with Disease Control

11:20 – 11:50  S. Blake Allan, Justin Kim, Greg Michajlyszyn, and Don Rung
Explicit Krein Resolvent Identities for Singular Sturm–Liouville
Operators with Applications to Bessel Operators

12:00 – 12:30  Nafisa Tabassum and Carolyn Valenti
A Multi-Scale Model for Cholera Dynamics

NSF REU Site: Research Training for Undergraduates in Mathematical Analysis with Applications in Allied Fields. Preprints will be available on the REU website and arXiv.org, and submitted for publication in peer-reviewed journals.

We gratefully acknowledge the National Science Foundation Division of Mathematical Sciences for its generous support.
Lower Bounds for the $L^1$ Norm of Exponential Sums

We employ the method of Balog and Ruzsa and the large sieve to investigate the behaviour of the $L^1$ norm of a wide class of exponential sums over the square-free integers and the primes. Moreover, we provide a new proof of a lower bound due to Vaughan for the $L^1$ norm of an exponential sum with the von Mangoldt $\Lambda$ function over the primes.

Modeling Cholera Transmission with Disease Control

We construct a new mathematical model to investigate the transmission dynamics of cholera under the impact of disease control measures, particularly with awareness programs and water sanitation. The model incorporates the impact of awareness programs into the disease transmission rates, and that of water sanitation into the description of the environmental pathogen evolution. We conduct a careful mathematical analysis to the model and establish the local and global stabilities, characterized by the basic reproduction number, for the disease-free and endemic equilibria. In addition, an optimal control study is in progress to explore effective prevention and intervention strategies for cholera epidemics.
Explicit Krein Resolvent Identities for Singular Sturm–Liouville Operators with Applications to Bessel Operators

We derive explicit Krein resolvent identities for generally singular Sturm–Liouville operators in terms of boundary condition bases and the Lagrange bracket. As an application of the resolvent identities obtained, we compute the trace of the resolvent difference of a pair of self-adjoint realizations of the Bessel differential expression. The resulting trace formula is then used to determine the spectral shift function for the pair.

A Multi-Scale Model for Cholera Dynamics

A multi-scale mathematical model for cholera dynamics is developed and analyzed. The model links the within-host and between-host disease dynamics and their interaction with the pathogen in the aquatic environment. The within-host, between-host and environmental sub-systems are on the fast, intermediate, and slow time scales, respectively. A study based on separation of scales is first performed for each of the three sub-systems. Properties of the trivial and non-trivial equilibria are thoroughly investigated and threshold-type results are established. The analysis is then extended to the full system coupling the three time scales.