COLLEGE OF
Saint Benedict Saint John's
UNIVERSITY

SPRING 2023 PI MU EPSILON CONFERENCE PROGRAM

All presentations will occur in **PENGL** on the Saint John's University campus. Below is the schedule of talks, with room information and Zoom links provided, followed by the abstracts (beginning page 2) for each talk. The Zoom information has also been posted to the conference webpage.

SCHEDULE FOR FRIDAY, APRIL 14.

Hands-on origami session: with Dr. Thomas Hull
Time: 6:30pm - 7:20pm CST
Room: PENGL 269

Undergraduate research presentation: Zora Mihelich
Time: 7:30pm - 7:55pm CST
Room: PENGL 229

Undergraduate research presentation: Aidan Thomas
Time: 8:00pm - 8:25pm CST
Room: PENGL 229

Keynote Address #1: Dr. Thomas Hull
Time: 8:30pm - 9:30pm CST
Room: Pellegrene Auditorium (or via Zoom)

SCHEDULE FOR SATURDAY, APRIL 15.

Open problem session: Breakfast with a side of math
Time: 8:30am - 9:20am CST
Room: PENGL 269

Undergraduate research presentation: David Miller
Time: 9:30am - 9:55am CST
Room: PENGL 229

Keynote Address #2: Dr. Thomas Hull
Time: 10:30am - 11:30am CST
Room: Pellegrene Auditorium (or via Zoom)

PRESENTATION ABSTRACTS.

Keynote Address #1 - Friday, April 14, 8:30pm.
Speaker: Dr. Thomas Hull (Western New England University)
Origami: Doing Math and Science without Scissors or Glue - Origami, the art of paper folding, has been practiced in Japan and all over the world for centuries. However, the past decade has witnessed a surge of interest in using origami for science. Applications in robotics, airbag design, deployment of space structures, and even medicine are appearing in the popular science press. Videos of origami robots folding themselves up and walking away or performing tasks have gone viral. What's more, the National Science Foundation has found origami valuable enough to fund millions of dollars towards studying engineering and science applications of origami art. But if the art of paper folding is so old, why has there been an increase in origami applications now? One answer is because of math. Advances in our understanding of how folding works has arisen due to success in modeling origami mathematically. In this presentation we will explore why origami lends itself to mathematical study and see how origami-math has inspired science applications as well as influenced origami as an artistic medium.

Keynote Address #2 - Saturday, April 15, 10:30am.
Speaker: Dr. Thomas Hull (Western New England University)
Rigid Origami and No-hands Folding - As mentioned in the first talk, origami has enjoyed increased attention in math and science over the past 10 years. One aspect that has especially blossomed is rigid origami, where we insist that the origami model can be smoothly folded and unfolded with the faces of paper between the creases remaining flat (or rigid, as if they were made of metal or wood). Engineers especially like rigid origami as a way to design interesting mechanisms that work at large scales (think solar panel arrays) and tiny scales (think folded capsules and stents in the human body).

To actuate a rigid origami mechanism without the aid of human hands, we apply driving forces to the crease lines, such as with springs. We say these driving forces make the origami model self-fold. In doing this we often confront a problem where it is not possible to predict the way the springs will make the model fold from the unfolded state. In this talk we will develop a mathematical model of self-folding and describe how to design a driving force such that a given crease pattern will uniquely self-fold to a desired mode without getting caught in a bifurcation. We'll use linear algebra to find necessary conditions for self-foldability and see how it works on actual examples. This is joint work with Tomohiro Tachi (University of Tokyo), my students at Western New England University, and was partially supported by NSF grants EFRI-1240441 and DMS-1906202.

Undergraduate presentation - Friday, April 14, 7:30pm.
Speaker: Zora Mihelich (College of St. Benedict and St. John's University)
A Game of Removing and Adding Perfect Squares - We consider a game between two players who alternately add or remove stones from a pile of stones. On each turn, the player needs to determine the largest perfect square that is less than or equal to the number of stones in the pile; the player then decides to either add or remove that number of stones. For instance, if there are 19 stones in the pile, then 16 is the largest perfect square that is less than or equal to 19; the player then decides whether to remove 16 stones (leaving $19 - 16 = 3$) or add 16 stones (leaving $19 + 16 = 35$) to the pile. The player who removes the last stone from the pile wins.

It is an open problem to determine the outcomes for any pile of stones. We discuss some partial results that we got from a capstone course in mathematics.

Undergraduate presentation - Friday, April 14, 8:00pm.
Speaker: Aidan Thomas (College of St. Benedict and St. John's University)
Games on More than Dihedral Groups - In this talk we will discuss a pair of games played on groups. The games consist of two players picking symmetries of a group and applying them sequentially. Once all the symmetries have been used, the game ends and then we can determine which player won. We will discuss research done by Emily Twardy in "Games on Dihedral Groups," that looked at these games on dihedral groups and how I will use it to research these games on other groups this summer.

Undergraduate presentation - Saturday, April 15, 9:30am.
Speaker: David Miller (Concordia College)
Weight Biquandle Polynomial Invariant - Knot theory is the mathematical study of knots and a sub-field of topology. Virtual knot theory is an extension of knot theory which broadens how many objects we can study. To put it in perspective, there is only one 4-crossing classical knot but over 500 virtual knots with 4 crossings! However, with this broadened view of knot theory, it is more needed to distinguish between two knots. Our research builds and expands upon the Generalized Alexander polynomial and Z-parity polynomial to create a new polynomial that is nonzero when the previous two are not.

Open problem session - Saturday, April 15, 8:30am.
This morning session will be held in the room where the breakfast/refreshments will be served. It is meant to be time during which participants can explore math problems together. The problems have a low entry point, i.e. no technical knowledge is required. You are also welcome to share a problem you find interesting (whether you know a solution or not) during this session.