SWiM 2019
Go with the Flow!

Are you ready to make some waves? Navier-Stokes equation is used to model waves, aquatic animal locomotion, aerodynamics, blood flow, thin film lubrication, and much more! These models help researchers predict the weather, develop new medication, and create realistic animation in films. In this course, we will look at how to mathematically model fluid motion and many other natural phenomena. You will learn the meaning behind several differential equations including Navier-Stokes equation. You will also numerically solve various differential equations using basic programming techniques. No calculus or programming experience required.

Tentative Syllabus
Day 1: Intro to Differential equations
- Modeling
- Difference Quotients
- Differential Equations (Unconstrained Growth)
- Euler's Method
- Programming Single Variable Euler's Method (Homework)

Day 2: Systems of Differential Equations (Part 1)
- Logistic
- Rumor Spreading
- Programing Multi-Variable Euler's Method

Day 3: Systems of Differential Equations (Part 2)
- Predator-Prey
- Competition
- SIR

Day 4: Partial Differential Equations (Part 1)
- Poisson Equation
- Finite Difference Method
- Matrix Algebra

Day 5: Partial Differential Equations (Part 2)
- Programming in Octave
- 2D Laplacian

Day 6: Fluid-Structure Interaction
- Reynolds Number
- The Stokes Equations
- The Navier-Stokes Equations

Projects

1. **Cleaning Up the Great Lakes**

   The great lakes in North America are the largest surface freshwater system in the world. They hold 21% of the world's freshwater supply and supply water to 10% of Americans and 30% of Canadians. However, chemicals, toxic pollutants, pesticides, and heavy metals entered the Great Lakes from heavy industry, manufacturing, and agriculture. Students working on this project will investigate what it would take to clean up the lakes.

2. **Period Doubling and Chaos**

   The logistic equation is often used to model the growth of a population with a carrying capacity. In studying this dynamical system, the phenomena of period doubling and chaos are observed when computing numerical solutions. In this project students will investigate this interesting behavior.

3. **Stopping Fake News**

   In modern society, creating and disseminating information is easier than ever. While this allows access to information on unprecedented scales, the validity of the information can be difficult to determine. In this project, you will model the spread of fake news and investigate ways to deter distributing misinformation.

4. **Thanos Population Models**

   In the end of the "Avengers Infinity War," the villain Thanos snaps his fingers and turns half of all living creatures to dust with the hope of restoring balance to the natural world. In this project, you will investigate the validity of his claim using mathematical modeling.