Survey of Modern Math

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Course Description

Mathematics is a beautiful and highly diverse subject. In this course, students will explore just a few of the many areas of Mathematics. Topics include

- Differential Geometry
- Differential Equations and Chaos
- Algorithms
- Computational Geometry
- Number Theory and Cryptography
- Fractals and Complex Numbers

For a more detailed breakdown of the topics and schedule, see below.

Mathematica

Each day, the students will spend the afternoon session in a computer lab exploring these topics using Mathematica. Students are not expected to have any prior experience with Mathematica or other mathematical modeling software. The first day will be devoted to getting started in the program and the Wolfram Programming Language (the language that powers Mathematica).

Presentations

Students will choose a famous Mathematician to learn about and present to their classmates on the last day of class. Students will be provided with a list of potential people but may choose someone not on the list with permission from the instructor. More details will be provided separately.

Other Homework

Students will be assigned homework each night. Their solutions are to be handed in at the start of the next day's morning session. On some days, the homework will entail practice of that day's topics. On some days, however, the homework will be preparation for the next day's topics. Therefore, it is imperative that students complete the homework on time. If not, you will not be prepared for the next topic and will have difficulty getting the full benefit from the planned activities.

There is no assigned textbook for this course, so any assignments or notes will be provided by the instructor to the students. In most cases, the instructor will provide the students will printed copies. Students may also find all material posted to the instructor's website: http://www.math.rutgers.edu/~ceu11

Museum of Mathematics

In the afternoon of Thursday, July 10, we will be taking a field trip to the Museum of Mathematics in New York City. More details will be provided separately.

Day	Morning (Classroom)	Afternoon (Lab)
1 6/25	**Graph Theory: Paths** • Ice Breaker Activity • Seven Bridges of Königsberg	**Introduction to Mathematica** • Wolfram Starter Video
2 6/26	**Differential Geometry: Introduction to Curves** • Parametrized Curves • Curvature	**Differential Geometry: Modeling Curves using Mathematica** • Plotting the multiple curves
3 6/27	**Differential Geometry: Ovals** • Examples of Ovals • Width	**Differential Geometry: Shapes of Constant Width** • Shapes of Constant Width • Modeling
4 6/28	**Differential Equations: Introduction** • What is a Differential Equation • Separation of Variables • First-order Linear Equations	**Differential Equations: Solving ODEs using Mathematica** • Using DSolve • Plotting Solutions
5 6/29	**Differential Equations: Bifurcations and Systems of Equations** • Bifurcations • What is a system of differential equations	**Differential Equations: Bifurcations and Chaos** • Modeling Bifurcations • Chaotic solutions to the Lorenz Equations
6 7/2	**What is an Algorithm?** • Running Example: Fibonacci Numbers	**Introduction to Algorithms in Mathematica** • Fibonacci Algorithms
7 7/3	**Computational Geometry: Closest Points Problem and Computational Complexity** • Finding computational complexity • Why computational complexity is important • Closest Points Problem	**Computational Geometry: Closest Points Problem** • Finding the closest pair of points on a number line • Finding the closest pair of points in 2D • Faster Algorithms
8 7/4	**Fourth of July: No Classes**	
9 7/5	**Computational Geometry and Graph Theory: Minimizing Paths** • Dijkstra's Algorithm	**Computational Geometry: Shortest Path Problem** • Finding the shortest path between two points in the plane with polygonal obstacles
10 7/6	**Number Theory: Introduction** • Modular Arithmetic • Fast Modular Exponentiation (Khan Academy Article)	**Number Theory: Introduction** • Morning topics on the computer • Write an algorithm for fast modular exponentiation
11 7/9	**Number Theory: RSA and Public Key Encryption** • RSA Algorithm • How secure is RSA?	**Super-Secret Spy School** • Sending Encrypted Messages • Signing Encrypted Messages
12 7/10	**Fractals: Introduction** • Sierpinski Carpets	**MoMath** Field Trip
13 7/11	**Fractals: Complex Numbers and Iteration** • Iteration • Fixed points and cycles	**Fractals: Mandelbrot Set** • Plotting Julia Sets • Generating the Mandelbrot Set
14 7/12	**Fractals: Random Walks** • Random Walk Activity	**Fractals: Brownian Motion** • Graph morning's activity • Generate random walks • Histograms and timeline
15 7/13	**Presentations**	**Fun with Photos** • Photo Filters • Arnold's Cat Map