# MSCS MESS

Department of Mathematics, Statistics, and Computer Science
St. Olaf College, Northfield, MN 55057
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## Next Monday's Colloquium

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| Title: | An Introduction to Finite Element Methods |
| Speaker: | Minah Oh |
| Time: | 3:30 PM |
| Date: | October 29 |
| Place: | RNS 310 |

**About the talk:** When using computers to find a good approximation of the solution to a given problem, we want to use computational methods that are not only fast but also mathematically proven to give an accurate approximation. In this talk, we will discuss the importance of careful mathematical analysis of efficient computer algorithms and learn about popular numerical methods called the finite element methods (FEMs) that have a solid mathematical theory behind them. We will also discuss how the solution to a three-dimensional problem defined on an axisymmetric domain can be well-approximated by solving two-dimensional discrete problems instead and the detailed mathematics that is involved in justifying such dimension reduction. In addition to presenting the applications of the FEMs, I will also talk about what problems a mathematical error in these computational methods can cause. This talk will be accessible to undergraduate students that have seen calculus and a bit of linear algebra.

**About the Speaker:** Minah Oh is an associate professor of mathematics at James Madison University (JMU), and her main area of research is in numerical analysis. She has supervised many undergraduate research projects at JMU, and she also has a passion for popularizing mathematics to the general public. She is currently the Chair Elect of the Maryland-DC-Virginia Section of the Mathematical Association of America, and she also spent a year at St. Olaf College as an exchange student back in 2003.

## Next Tuesday's Research Seminar

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| Title: | Numerically Solving Axisymmetric Problems |
| Speaker: | Minah Oh |
| Time: | 3:40 PM |
| Date: | October 30 |
| Place: | RNS 204 |

**About the Talk:** An axisymmetric problem is a problem defined on a three-dimensional (3D) axisymmetric domain. It can be reduced to a sequence of two-dimensional (2D) problems by using cylindrical coordinates and a Fourier series decomposition. A discrete problem corresponding to the 2D problem is significantly smaller than that corresponding to the 3D one, so such dimension reduction is an attractive feature considering computation time. Due to the Jacobian arising from change of variables, however, the resulting 2D problems are posed in weighted function spaces where the weight function is the radial component $r$. Furthermore, formulas of the grad, curl, and div operators resulting from the so-called Fourier finite element methods are quite different from the standard ones. In this talk, we will discuss the mathematics that is involved in analyzing weighted 2D problems arising from axisymmetric 3D problems and how to construct efficient computational algorithms using finite element methods to solve the 2D problems numerically.

## MSCS Game Night Next Thursday!

Come by the sixth floor of RMS from 7-10 PM on November 1$^{st}$ for an evening of board games and various orange snacks!

## Next Friday's Research Seminar

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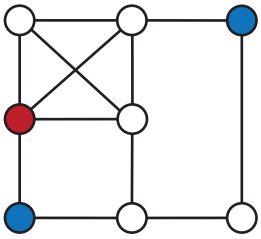
| Title: | Throttling for Zero Forcing and Cops and Robbers |
| Speaker: | Joshua Carlson |
| Time: | 3:40 PM |
| Date: | November 2 |
| Place: | RNS 204 |



Does this sound or look familiar? It might if you attended the colloquium on Zero forcing earlier this year by Professor Bozeman!

**About the Talk:** Zero forcing is a process on a graph in which the goal is to force all vertices to become blue by applying a color change rule. There are many variants of zero forcing that alter the color change rule. Cops and robbers is a game played on graphs in which a team of cops moves along the edges of the graph in order to catch the robber. Both zero forcing and cops and robbers require initial resources. In both cases, changing the initial resources affects the time required to complete the process. Throttling minimizes the sum of the amount of initial resources and the completion time. This talk will present results on throttling for variants of zero forcing and cops and robbers.

**About the Speaker:** In 2010, Josh came to Iowa State University to become a secondary mathematics teacher. After participating in a summer Research Experience for Undergraduates (REU), he decided to extend his reach as an educator to the college level. In 2014, he enrolled in the graduate program in mathematics at Iowa State. His research interests include zero forcing, cops and robbers, power domination, and throttling. It is now his last year as a PhD student and he maintains a strong passion for teaching and undergraduate research. He is currently serving as the Lead Teaching Assistant in his department. This fall, he will be applying to faculty positions at various liberal arts and regional colleges in the Midwest.

## Math Club T-Shirt Design Contest

Do you have a knack for design? Interested in potentially winning a free shirt/eternal glory? Simply enjoy math? Consider submitting a design for this year's Math Club/PME shirts! Designs should be related to math and use no more than three colors. Submissions and queries should be sent to snavel1@stolaf.edu. Designs are due by Nov. $7^{\text{th}}$.

## Career Corner: Operations Research Analyst

Career Corner will be an occasional section of the MSCS Mess that highlights a potential career path for grads.

Operations researchers help organizations plan and operate in the most efficient and effective manner. They use mathematics to forecast the implications of various choices and decide on the best alternatives. Types of models they use include simulation, linear programming, networks, and game theory. Problems that a researcher would solve include how to optimally schedule flights and employees at an airline and how to use different strategies to best protect a species. If this sounds interesting, consider taking MATH 266 to learn more!

*To submit an article, event, or anything else for publication in the mess, email* jadkow1@stolaf.edu*; to receive the Mess digitally each Friday, email* habero1@stolaf.edu*; visit* http://wp.stolaf.edu/mscs/mscs-mess/ *for a digital archive of previous MSCS Mess issues.*

Will Jadkowski, Editor
Dave Walmsley, Faculty Adviser
Ellen Haberoth, Mess Czar

American Statistical Association—2018 Joint Statistical Meeting

The 2018 Joint Statistical Meetings took place in Vancouver, in the beautiful province of British Columbia. The meeting was a success, with many opportunities to #LeadWithStatistics—JSM's theme this year. In attendance were 6,346 people (including 3,336 ASA members). There were 925 professional development registrants and 230 exhibitors. The program included scientific sessions of interest to statisticians working in academia, the government, and industry with topics such as clinical trials, precision medicine, high-dimensional data, big data, data science, and machine learning, as well as many topics linked to societal issues.

Honored at the President's Address Awards Ceremony, Professor Paul Roback was inducted this year as an ASA Fellow. Each year, ASA Fellows are nominated by the membership and selected by the ASA Committee on Fellows. Previous years fellows also include Professor Julie Legler.

*Congratulations Professor Roback* *October 2018 issue AMSTAT News*

# Interim and Spring Course Information

2019

This is a compilation of descriptions of *upper level* courses in the MSCS department. Where a course has no professor-provided description, the catalog description will be used. Additionally, 1xx and 2xx level courses will be omitted from the list of course descriptions. For the full class and lab schedule, refer to https://www.stolaf.edu/sis/public-aclasslab.cfm.
For information on course offerings in upcoming years, consult the guides linked at https://wp.stolaf.edu/mscs/mscs-course-planning-guides/.

## Notable Recent Schedule Changes

As professors have been finalizing their plans for the spring semester, some courses will now meet at different times. Some sections will have different professors, but those updates will not be noted here.

Interim - Stat 284 Biostatistics will be offered during Interim

Spring Semester - Math 244 B time change to MWF 11:50-12:45

Spring Semester - Math 340 time has changed to MWF 2-2:55 pm

Spring Semester - CSCI263 Ethical Issues in Software Design has moved the time to Monday 7:00-10:00 pm.

## Interim Descriptions

**MATH 356: Geometry with Professor Matsuura**
Euclid's famous fifth postulate states: Given a line $\ell$ and a point $P$ not on $\ell$, there exists exactly one line through $P$ that is parallel to $\ell$. (Can you draw a picture of this?) But what if there are more than one such parallel line? Then we obtain a different kind of geometry, called *hyperbolic* geometry. In Math 356, we still study various kinds of geometries, including Euclidean (briefly), finite, hyperbolic, and spherical. Then we'll take a transformation approach (vectors, matrices, etc.) to Euclidean geometry. The course ends with a brief look into fractal geometry—lots of beautiful structures! Through group projects and presentations, students will also investigate additional aspects of geometry. The course sequences with Math 220 for IMaP purposes and is offered each Interim.
Prerequisites: MATH 220, and MATH 244 or MATH 252.

## Spring Descriptions

**MSCS 341: Algorithms for Decision Making With Professor Richey**
Today's world is awash in data. The challenge is how to extract information from this data in way that informs decision making. The best ways to do this involve advanced techniques and ideas from mathematics, statistics, and computer science. In this course, we will use the R programming language as an environment for implementing algorithms such as random forests, support vector machines, bagging, boosting, and k-means clustering. Some experience with programming in R, Python, or Mathematica is expected.
Prerequisites: MATH 220, CSCI 251, or STAT 272 or permission of the instructor.

**MATH 340: Complex Analysis with Professor Richey**
Complex analysis treats the calculus of complex-valued functions of a complex variable. Familiar words and ideas from ordinary calculus (limit, derivative, integral, maximum and minimum, infinite series) reappear in the complex setting. Topics include complex mappings, derivatives, and integrals; applications focus especially on the physical sciences.
Prerequisites: MATH 220, and MATH 226 or MATH 244.

**MATH 352: Abstract Algebra II with Professor Dietz**
If you loved Abstract I, you'll love Abstract II twice as much! We'll dive further into both group and ring theory, tying the two together with Galois' famous theorem that relates the roots of polynomials to certain groups. Don't worry if you took Math 252 a year or two ago–the group theory tends to come back pretty quickly, and we'll review ring theory when the time

comes. This course is a must for anyone considering graduate school in mathematics, and is really good for those physics and computer science majors who enjoyed abstract algebra.
Prerequisite: MATH 252.

**MATH 382: Pure Mathematics: Analytic Number Theory with Professor Grodzicki**
Humanity has been investigating the properties of the natural numbers for millenia (seriously – Euclid's proof of the infinitude of primes dates back to around 300 BC). This course will skip forward a couple of thousand years and focus on exploring the (often surprising) connections between Calculus and the structure of the natural numbers. For example, we will see how analysis can be used to enhance our understanding of the distribution of the primes, as well as how analysis can be used to highlight the appearance of primes in various evenly-spaced sequences of integers. Topics will range from Goldbach's problem and the circle method to the Riemann zeta function and random matrix theory. The only prerequisite is Math 244; we will discuss whatever material we need from algebra, probability, complex analysis, or Fourier analysis. In particular, no background in number theory is assumed. This course will count towards a 2-3 sequence for the IMAP

**MATH 384: Financial Mathematics with Professor McKelvey**
Wall Street is awash in exotic financial instruments. Math 384: Mathematics of Finance, is about exploring the mathematical properties of these instruments and, more importantly, combinations of these instruments. This course will not make you rich, but will help you understand some important aspects of institutional high finance. The misuse of these instruments are blamed, by some, for the financial crisis of ten years ago. Some argue that we are currently in the early stages of a similar fiasco in the near future.

The financial instruments we will discuss include forward and futures contracts, call and put options, foreign exchange trading, and the more mundane stocks and bonds. A particular focus will be the pricing of these instruments. It is important to understand this pricing because deviation from the correct price, by you or others in a market, typically opens up arbitrage opportunities, the chance to make money without risk.

In addition to discussing individual instruments, we will discuss hedging and portfolio design that allow investors to take advantage of very clever combinations of financial instruments.

Prerequisites: MATH 220 and one of MATH 244 or MATH 252

**STAT 316: Advanced Statistical Modeling with Professor Roback**
If you liked Stat 272: Statistical Modeling, you'll love Stat 316 Advanced Statistical Modeling. It turns out many of those things we must assume to fit linear regression models are often violated in real life. Education studies have students within classroom within school (not independent); ecological data involves counts of species (not normal); political data involves candidates within districts within states (not independent); public health data examines cases per 10,000 people over time (not normal and not independent). In this course, we build on your knowledge of multiple linear and logistic regression from Stat 272 to fit and interpret models for non-normal and correlated data. In the process, we explore tons of real and interesting case studies.
Prerequisite: STAT 272.

**CS 333: Theory of Computation with Professor Allen**
In this course we study abstract models of a computer, starting with finite automata, progressing to pushdown automata, and ending with Turing machines. Equally important will be the languages these models support, namely regular languages, context-free languages, and recursive languages. Along the way, classic issues in computer science arise: determinism, non-determinism, grammars, context-free languages, decidability, and complexity.
Prerequisite: CS 251.

**CS 336: Logic Programming with Professor Allen**
Logic Programming is one of the major programming paradigms that was originally inspired by first order logic, a formal system of mathematical deduction. A logic program is a collection of facts and relationships. An execution of such a program produces new information and relationships that can be deduced from the given ones. Logic programming developed as one of the two main approaches to formulating problems in artificial intelligence.
Prerequisite: CS 251.