Winter 2013 Comps Presentations

On Thursday, February 21, there will be three group comps presentations from 3:30pm-7:00pm in Olin 141. Dinner will be served at 5:30pm.

Modeling the Ames Mill Dam (3:30pm)
Emily Gruber, Andria Hall, Tommy Keller, Gabriella Newman

Our project is a continuation of a former St. Olaf interim math practicum. We are modeling the Cannon River so that we can analyze the state of the river with and without the Ames Mill Dam. We are using HEC-RAS, a river modeling software program, to conduct a sensitivity analysis of important river characteristics. Our focus is to answer specific questions relating to the effects of removal of the Ames Mill Dam.

Faribault Woolen Mill: The Effect of Different Speed Levels on Overall Yarn Performance (4:30pm)
Megan Bakken, Cassie Mullen, Yansong Pang, Wenli Rui

In 2009 due to the economic recession the woolen mill in Faribault was forced to shut its doors after over 100 years in operation. Recently, two cousins have reopened the mill reinstating not only a company but an integral part of the community. Our project aimed to help monitor efficiency in some of the machines at the mill. Throughout the presentation the viewer will gain knowledge of statistical sampling, a traditional multiple linear regression model, and the avant-garde Zero-Inflated Poisson model. Come join the adventure!

Combinatorial Species and Graph Enumeration (6:00pm)
Andy Hardt, Pete McNeely, Tung Phan, Justin Troyka

One of the major projects of combinatorics is to count all the graphs with a given property. In some settings, it is important to think about these graphs with labels on them, but in other settings only the “shapes” of the graphs are important. We will introduce the theory of combinatorial species, a novel toolset which provides a rigorous foundation for dealing with this distinction. We’ll then show how this theory can be used to solve open problems in graph enumeration, including counting so-called “point-determining bipartite” graphs.

Go with the Flow and Come to This Tour Talk

This week, (Friday, February 15, 3:30pm, CMC 209) the Tour of Mathematics will feature Jack Goldfeather, who will speak on “The Euler Characteristic and Flows on Surfaces”. As always, all are welcome!

Spring Term Course Offerings

Math 236: Mathematical Structures
Instructor: Jack Goldfeather
Time: 2a
Prerequisite: Math 232, or consent of instructor

What does it mean to “create” mathematics? How do we know that all the theorems we use in applying mathematical theories to other disciplines are valid? This course is intended to introduce students to the ways in which mathematicians try to answer these questions.
Amidst all the mathematical formality, you will discover some remarkable facts. In particular, you will learn that when Buzz Lightyear said “To infinity and beyond!” he was being mathematically precise.

Math 236 is the last course in the math sequence that is required of all math majors, and is the first course that suggests what being a math major (as opposed to a math user) is all about. If you are undecided about majoring in math, taking this course before you make the decision might prove helpful.

**Math 241:** Ordinary Differential Equations  
**Instructor:** Mark Krusemeyer  
**Time:** 3a  
**Prerequisite:** Math 232 or consent of instructor

In calculus you may well study separable first-order differential equations for a bit, but that’s just the tip of the iceberg! In any field where mathematics is applied, you are likely to find equations relating unknown functions and their derivatives.

Over the centuries, following the lead of Newton, Leibniz, and the Bernoullis, mathematicians have come to grips with many such equations. Naturally, they prefer to get exact solutions if possible, and we’ll look at some of the systematic methods (and a few of the clever ad hoc tricks) that have been developed to find solutions. On the other hand, there are times when finding an exact solution is too difficult, or even potentially misleading—for instance, because the mathematical model that leads to the differential equation is imprecise to begin with. In such cases, it is often best to concentrate on the qualitative behavior of solutions; for example, you might try to predict what will happen in the long run.

In this course, you’ll find plenty of calculus-style computation, including ample opportunity to brush up on your techniques of integration (Mathematica can help with some of that), but also a few theoretical discussions, some geometric ideas, and a bit of mathematical modeling. The textbook we’ll be using, which was written by a close (younger!) relative, does not presuppose much linear algebra, but concepts from linear algebra, ranging from vector spaces of functions through linear transformations and kernels to eigenvalues and eigenvectors, will be mentioned and used with some regularity in class.

(If this description looks strangely familiar, it may be because the same class is happening this term.)

**Math 245:** Applied Regression Analysis  
**Instructor:** Katie St. Clair  
**Time:** 5a  
**Prerequisite:** Math 215 or Math 275

Model building is a fundamental idea in statistics. In an intro stats class you’ve learned some basic techniques for modeling a response as a linear function of one explanatory variable (simple linear regression). In this second stats course you will learn more advanced techniques for building regression models that can include many explanatory variables (multiple regression) or a categorical response (logistic regression). We will apply these techniques to explore how air pollutants might affect mortality, whether sex plays a role in determining a worker’s salary, and how a national tragedy was predicted by a regression model. This course emphasizes model building and checking techniques and statistical writing. We will meet in the stats lab and use the free statistical software R. As the title suggests, this is an applied course so you will be working with new data sets each week, and you can expect to be a seasoned R user by the end of the term!

**Math 295:** History of Mathematics  
**Instructor:** Steve Kennedy  
**Time:** 2,3c  
**Prerequisite:** Math 236

An extended and in-depth case study of the acceptance by the mathematical community of the complex numbers. We will do this by reading the original works that gave birth to the relevant ideas. We will begin in sixteenth-century Italy with the work of Cardano and Bombelli, move to France to read Viète and Descartes and then...
meet with Wallis, Newton, deMoivre, Euler and at least one Bernoulli. We finish, early in the nineteenth century, with Wessel and Argand who provided the now commonplace geometrical interpretation of the complex numbers. We will proceed seminar-style with students doing the vast majority of the presenting.

Math 312: Elementary Theory of Numbers
Instructor: Rafe Jones
Time: 4a
Prerequisite: Math 236 or consent of instructor

Number theory begins -- but certainly doesn't end -- with the prime numbers, objects whose mysteries have persisted for thousands of years. The known and the unknown live side by side: how many prime numbers are there? How many prime numbers are there that are one more than a square? Euclid beautifully answered the first question 2300 years ago, while to date no one has answered the second. We will examine properties of the primes at length, and have some opportunities for experimental discovery -- sometimes leading to subsequent proof. Along the way, we will brush up against some spectacular open problems.

In addition to primes, congruences will be our other main concern (with a selection of other topics to follow). For centuries number theory formed the cornerstone of ‘pure’ mathematics -- that without any conceivable practical application. But very recently primes and congruences have been put to use in cryptography, and now play a role in vast numbers of everyday online transactions. We’ll discuss how this works, and how it depends on no one being able to find a fast factorization algorithm for large numbers. Extra credit if you discover such an algorithm.

Math 315: Stochastic Processes
Instructor: Bob Dobrow
Time: 4a
Prerequisite: Math 265 and 232 or consent of instructor

A stochastic, or random, process is a collection of random variables defined on a common prob-
anything about the properties of its solutions? In particular, how well can we approximate solutions with or without computers?

As the course title suggests, we will be exploring what is known as the Fourier method for solving such problems. This method not only leads to Fourier series, but also to a theory of orthogonal functions and their associated generalized Fourier series.

Math 349: Methods of Teaching Math
Instructor: Deanna Haunsperger
Time: 2,3c
Prerequisite: Junior or senior standing and instructor consent

How is mathematics taught? You’ve certainly seen mathematics taught, and if you’re a tutor or have a friend in a lower-level math class you’ve probably done some teaching. What’s the best way to teach? Is there a best way to teach? How do students learn mathematics? What is a lesson plan? What’s important when you’re in front of a classroom? Through (many) readings and some observations and practice, we’ll discuss these questions and you’ll develop your own answers.

Math 351: Functions of Complex Variables
Instructor: Steve Kennedy
Time: 3a
Prerequisite: Calc 3

Stone-age people started with simple, positive whole numbers and all was good. Then algebra forced us to accept fractions (3x=2), irrationals (x^2=2), and negative (yuck) numbers (3x+6=0). But, even then, we couldn’t solve x^2+2=0 until we admitted the complex numbers into our discourse. Surprisingly, at that point, we were provably done extending the number system; any polynomial with complex coefficients factors completely into linear factors over the complex numbers. We don’t (algebraically speaking) need any more numbers. So, we decided to do calculus with them. And the calculus of complex numbers, like the algebra of complex numbers, reassures us that we have reached the mathematical promised land. Having one derivative means you are infinitely differentiable, integration is a joy and a wonder. Algebraically, analytically, and geometrically the complex plane is where you want to be. In Math 351 we will prove that fact and explicate several of the many miracles to be found there.

Math 352: Topics in Abstract Algebra
Instructor: Mark Krusemeyer
Time: 5a
Prerequisite: Math 342 or consent of instructor

Were you expecting Abstract Algebra II? The name just changed (and the new name may not be everywhere on the Web yet) to reflect an exciting development: Our department now expects to offer a “second” abstract algebra course every year, and we intend never to cover the same topic in successive years; thus you will have the option of taking Math 352 two years in a row. This is effective immediately, and in particular there will be essentially no overlap between this class and the Math 352 Eric taught last year (and if you took that class, you’re welcome to take this one also).

So you liked Abstract Algebra I? Then it might get even better, because you now have the tools to study a particular topic or two in some depth. This year’s main topic is representation theory of finite groups. (For those of you who like to plan well ahead, next year’s Math 352 should cover field extensions and Galois theory.) Representation theory, which involves describing the structure of groups by using their homomorphisms to matrix groups, is used in classifying and predicting elementary particles (which we won’t do) and in chemistry, as well as in mathematics. Besides abstract algebra, we’ll use some linear algebra (to understand the matrix groups, for one thing). There are quite beautiful results to look forward to, but it’s hard to state those before you really get into the material.

This will be the first time I have a chance to spend an entire term on representation theory (when I’ve taught Math 352 in the past, the time was split between that and Galois theory), so I’m not entirely sure how far we’ll get; that also depends a bit on the background and interests of
the participants. (There will be no textbook, although there will be a variety of books available for reference.) It should be an adventure! If you’re not sure whether to join, feel free to stop by to talk about it; I may be able to give you a better idea of the flavor of the material than I could possibly do in this space. Taking Math 352 once or twice is definitely recommended if you are thinking of graduate school in pure mathematics, but people with no such plans are welcome too!

**Largest Known Prime Discovered!**

If you are not up-to-date on the latest mathematical news, you will be excited to learn that the largest known prime number has recently been discovered. It is more than 17 million digits long. While Euclid proved that there are infinitely many primes, there is no simple algorithm for finding them. Curtis Cooper, a professor at the University of Central Missouri and a volunteer at the Great Internet Mersenne Prime Search (GIMPS), was the lucky man who found that $2^{57,885,161} - 1$ is in fact a Mersenne Prime (of the form $2^p - 1$). Proving this took over five weeks of computing!

Interested in finding prime numbers? If you can find a prime that is at least one billion digits long the Electronic Frontier Foundation will award you $250,000. This newly discovered number received a $3,000 prize from GIMPS. To read the whole story, visit: http://lightyears.blogs.cnn.com/2013/02/06/largest-prime-number-yet-discovered/?hpt=hp_t2.

**PROBLEMS OF THE WEEK**

1. A circular disk of radius $R$ is to be moved from the “extreme left” to the “extreme right” of the coordinate plane (from $x = -\infty$ to $x = \infty$) in such a way that the disk always stays between the parabola $y = x^2$ and in a single line of the form $y = C(x - 18)$. (The disk is allowed to touch the parabola and/or the line.) Find the value(s) of $C$ that allow(s) for the largest possible $R$, and find that $R$.

2. If you write down Pascal’s triangle of binomial coefficients and look at the diagonals running from the upper left to lower right, you’ll first see $1, 1, 1, ...$; call this the 0-th diagonal. The next diagonal is 1, 2, 3, 4, ...; note that adding the reciprocals of the numbers in this first diagonal leads to the divergent (harmonic) series $1/1 + 1/2 + 1/3 + 1/4 + \ldots$.

However, for all later diagonals the corresponding series of reciprocals will converge. So for any integer $k \geq 2$ we can consider the sum of that series of reciprocals of the numbers in the $k$-th diagonal; for instance, for $k = 3$ this would be $1/1 + 1/4 + 1/10 + 1/20 + \ldots$.

Find the value of this sum, as a function of $k$.

Since the last set of acknowledgments (two weeks ago), here’s what’s new: Justin Troyka solved both problems posed January 25, and Dylan Peifer proved his conjecture, thus completing his solution of the second 1/25 problem. The first problem posed February 1 was solved by Milan Cvitkovic, by Dylan, and by John Snyder in Oconomowoc. So far, the second 2/1 problem was solved only by Dylan (that I know of). As for last week’s problems, the second was solved by John Snyder and by Dylan, while the first one was solved by the team of Dylan and Ben Strasser. Justin, Dylan, and the team are invited to collect something from the BBOP. Good luck on the new problems!

-Mark Krusemeyer

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**Problems of the Week:**

Mark Krusemeyer

**Subscriptions & Web:**

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