Instructor: Dr. Neal Smith  
Phone: 737-1672  
Office: Allgood N319  
Office Hours: How about 8:00-10:00 MW, and by appointment. As chair, I sometimes get dragged into meetings on short notice, so sometimes I may have to reschedule these hours.  
Prerequisite: MATH 2012 (Calculus II) or permission of instructor. A basic working knowledge of series will be needed.  
Text: Proofs that Really Count: The Art of Combinatorial Proof, by Benjamin and Quinn. For parts of the course, we will use the text, but much of the course material will come from outside the text. It's more of a reference than a textbook, so be advised of that.

Grading: Your grade will be determined by your performance on 2 ‘mid-term’ exams, homework, and a final exam; each mid-term will count for 30% of your grade, the final 30%, and homework will count for the remaining 10%.

If your final percentage is in the interval... Your course grade is...
[80%, 100%]     A  
[70%, 80%)     B  
[60%, 70%)     C  
[40%, 60%)     D  
[0%, 40%)      F  

Other Policies:

Attendance: I'm not the attendance police, but you need to be here every day. Now that you're in the world of upper-division courses, frivolous absence is a bad thing. You never know if you might want someone to write you a recommendation letter someday. If you know you will be absent on a given day for a legitimate purpose, it is expected that you will notify me beforehand.

Make-ups: I do not like to do make-ups. Generally, I will solicit the class’ input on scheduling dates for exams, usually 2-3 weeks in advance of the test. If people have legitimate reasons for not wanting a test on a certain day, I'll weigh them at that time.

Grading philosophy: A large component of this course deals with how to put together a coherent mathematical argument. Homework and exams will be graded with this in mind; thus you should make things as clear, neat, and organized as possible to ensure that you receive the proper credit for your work.

Grading philosophy, specifics: On homework and exams, problems will typically be evaluated with the following rubric in mind.  
4-The problem is completely correct, beyond any reproach.  
3-The problem is ‘basically correct’, but there may be some problems with a minor detail, the proof may be not as well written as it should be, etc.  
2-The problem is almost complete. The key idea is there, but there may be some errors. Or, the problem is correct but the solution is poorly written.  
1-Shows some awareness of correct methods, but little to no progress towards an actual solution is present.  
0-Speaks for itself. What is written down is of no value with regards to a solution to the problem.

Honor Statement: Each student is responsible for maintaining academic honesty. You are free to work with others on homework assignments, but homework handed in should be your own and not simply someone else’s work with assorted single-bit replication errors. On any assignment which is designated as a ‘take-home exam’ or portion thereof, there shall be no collaboration of any kind between students.

Etiquette: Please be punctual and make sure your cell phone is turned off before coming to class.

Advice: You will probably find that we will not be able to spend as much time in class answering questions as anyone (myself included) would like. Please take advantage of my office hours. Get to know your classmates; the semester will probably be more productive (and more fun) if you get to know some people that you can work with. When the exam rolls around, see if you can explain stuff to the people in your study group!
Learning outcomes: In Mathematics, we have three core learning outcomes.

1. Graduates majoring in mathematics will gain a mathematical knowledge base including, but not limited to, calculus, set theory, logic, abstract algebra, real variables, and differential equations.

In this course, you will find that we often use techniques culled from all over the mathematical spectrum. Your knowledge of calculus will be tested, and some techniques in the course will bear a striking resemblance to things you’ve done/will do in Differential Equations.

2. Graduates majoring in mathematics can construct valid proofs.

An extremely useful mathematical method is the so-called “combinatorial proof” where a nontrivial mathematical identity can be derived and proved by counting some given set of objects in two slightly different ways. By the end of the term, you will be expected to be proficient in constructing such proofs.

3. Graduates majoring in mathematics can use mathematical techniques to solve problems.

Here, some specific outcomes involve the use of infinite series (“generating functions” in combinatorics-speak) and some big well-known theorems (Inclusion-Exclusion, Burnside’s Lemma) to solve counting problems.
Course Outline:
*---denotes topics where the textbook will be referred to often.

I. Preliminaries
   a. What is Combinatorics?
   b. Sets, functions, and bijections
   c. Mathematical induction

II. Basic counting techniques
   a. The addition and multiplication principles
   b. Permutations of a set
   c. Combinations of a set
   *d. The Combinatorial proof
   *e. The Binomial Coefficients
   *f. Binomial Coefficient Identities
   *g. Combinatorial Interpretations of the Binomial Coefficients
   h. The Binomial Theorem
   i. Multisets, the Multinomial coefficients, and the Multinomial Theorem
   j. The Inclusion-Exclusion Principle

***Exam 1 should happen around here***

III. More advanced counting techniques: Recurrences and Generating Functions
   a. Examples of recurrences
   *b. The Fibonacci sequence
   *c. Combinatorial interpretations of Fibonacci numbers
   d. Difference equations: homogeneous and inhomogeneous
   e. Techniques for solving difference equations
   f. Derangements of a set
   g. Review of Calc II: power series
   h. Generating functions: ordinary and exponential

***Exam 2 should happen around here***

IV. Some sort of advanced stuff
   *a. Stirling numbers of the second kind.
   b. The Difference Operator $\Delta$, a 'discrete derivative'
   c. Properties of $\Delta$, and difference tables.
   d. Discrete analogues of results from Calculus, including the Fundamental Theorem of Finite Differences, Summation by Parts, etc.
   d. Polya counting/Burnside’s Lemma.

Final exam: Friday May 6, 11:00-1:00