Basic Combinatorics

Math 40210, Section 01

Fall 2012

General Arrangements

- **Instructor**: David Galvin, 248 Hayes-Healy, dgalvin1@nd.edu. Feel free to email me anytime. I try to respond quickly to any question or comments.
- **Office hours**: Initially Mondays, 4pm-5pm. Also, meeting times outside my office hours can be arranged by emailing me – I have free hours most days (except Thursdays) of most weeks.
- **Lectures**: MWF 10.40-11.30, 105 Pasquerilla Center, August 22 – December 5.
- **Text**: *Combinatorics and Graph Theory* (2nd edition, 2008) by Harris, Hirst and Mossinghoff, Springer. ISBN: 978-0-387-79710-6 (Hardcover); 978-1-4419-2723-1 (Paperback).
- **Course website**: http://www.nd.edu/~dgalvin1/40210/40210_F12/index.html. This is where course resources — syllabus, homework, supplementary handouts, etc. — will be posted. (NB - when following this link straight from a pdf file of the general arrangements, the tilde in front of dgalvin1 sometimes causes a problem; if so just enter it manually)
- **Sakai**: http://sakai.nd.edu/. This is where grades will be posted.

About the course

- **Official course description**: An introduction to the theory of combinatorics. Topics include permutations, multinomial coefficients, the theory of enumerative combinatorics, pairing problems, recurrence relations, the inclusion-exclusion principle, graph theory, algebraic coding theory and symbolic dynamics.
- **Unofficial course description**: Combinatorics may broadly be defined as the study of discrete (as opposed to continuous) structures, and how these structures can be combined subject to various constraints. Typical of the sorts of questions that are asked in combinatorics are:
  - Does there exist a structure satisfying such-and-such a condition?
  - How many such structures are there?

– Among all structures satisfying the condition, which is the largest, or smallest?

In this course, we will focus on two specific areas within combinatorics. The first half of the semester will be concerned with *graphs*. A *graph* is a set of points, some pairs of which are joined by lines. Graphs can be used as models of many phenomena — transportation networks, friendship networks, assignments of jobs to workers, ... We'll look at distance in graphs, a special class of graphs called *trees*, problems concerning walking around graphs and drawing them, and a number of other graph theory notions. We will not cover all of Chapter 1 of the textbook, but we should hit topics from most sections. In the second half of the semester, we will address enumerative combinatorics, and look at many basic and not so basic techniques for counting how many objects there are that satisfy some given properties. Topics to be covered include the pigeonhole principle, the principle of inclusion-exclusion, and the method of generating functions. We should cover topics from most sections of Chapter 2 of the textbook.

- **Prerequisites**: Formally the course has no prerequisites, and the material is introductory. However, as befits a 400 level course, the treatment will be rigorous. You will be expected to know precise definitions, statements of theorems and how to prove them.

  We will make much use of the basic mathematical language of sets and functions, and the techniques of induction and recursion. If you have taken a course such as Math 20630 (Introduction to Reasoning), you will already be fully familiar with everything we will use. If not, then you will be able to pick it up as the semester progresses. Some suggested readings to help you in this process will be posted on the course website.

- **Course objectives**: Over the course of the semester, you will learn some of the fundamental concepts and theorems in enumerative combinatorics and graph theory. You will be able to apply these concepts and theorems to solve problems, and either prove or disprove statements about basic combinatorial objects.

Course work

- **Homework**: I will announce homework most Fridays, and post it on the website. I will collect the homework in class on Fridays, and grade selected questions. Homework (equally weighted week by week) will count 100 out of 450 points of you final mark. Late assignments won't be accepted, except by special arrangement before the assignment is due.

  Homework is an essential part of your learning in this course, so please take it very seriously. It is extremely important that you keep up with the homework, as if you do not, you may quickly fall behind in class and find yourself at a great disadvantage during exams.

  More information about homework will be given along with the first assignment.

- **Quizzes**: Roughly every second Wednesday there will be a quiz in class, the general topic for which will be announced on the previous Monday. These quizzes count (equally weighted) for 100 out of 450 points of you final mark.

- **Exams**: There will be one in-class midterm (tentatively set for October 10) and a (cumulative) final on Monday December 10 from 4.15pm to 6.15pm. Specific exam policies (such as format, which sections will be covered, dealing with conflicts, ...) will be announced in class closer to the time. The midterm will count for 100 out of 450 points for your final mark, and the final will count for 150 out of 450 points.
- **Final grade**: A 92% average will earn you an A/A- overall; an 80% average a B+/B/B-; and a 65% average a C+/C/C-.
- **Grading disputes**: If you have any issue with the grading of your homeworks, quizzes or exams, you should let me know within seven days of receiving the work back; otherwise I can't promise anything.
- **Math for Everyone**: The department runs a series of "Math for Everyone" talks, which I can highly recommend (see

  `math.nd.edu/undergraduate-program/math-for-everyone-series/`).

  Write a short report on your reaction to one of these talks during the semester for 4 points extra credit (more details closer to the date of the first talk, September 13).

Conduct

- **Honor code**: You have all taken the Honor Code pledge, to not participate in or tolerate academic dishonesty. For this course, that means that although you may (and should) discuss assignments with your colleagues, you must write the final version of each of your assignments on your own; if you use any external sources to assist you (such as other textbooks, computer programmes, etc.), you should cite them clearly; your work on the mid-semester exam and the final exam should be your own; and you will adhere to all announced exam policies.
- **Class conduct**: The lecture room should be a place where you should feel free to engage in lively discussion about the course topic; don't be shy! But non course related interruptions should be kept to a minimum. In particular, you should turn off or switch to silent all phones, etc., before the start of class. If for some good reason you need to have your phone on during class, please mention it to me in advance.
- **A general comment**: Like many other endeavors (such as driving a car or mastering a piece of software), mathematics is something that you learn by doing. Attending class and reading the appropriate sections of the textbook is very important, but isn't enough to do well. After each lecture you should work through every example and proof from your class notes. Don't be perturbed if you have to re-read and re-do some topics many times before you begin to feel that you are mastering them. That is just how mathematical learning goes. It's a slow process, but a worthwhile one.

  If after struggling with a topic you still feel like you are making no headway, don't give up! Leave it aside for a while to let your unconscious brain work on it. Then go back to it, and talk it over with you colleagues, and come talk to me. It's what I'm here for!