

Math 3012, Applied Combinatorics

May 25, 2010

Instructor: Ernie Croot

Class Meeting Time and Place: TR 10:00-11:45, 170 Skiles.

Textbook: *Discrete and Combinatorial Mathematics*, by Ralph P. Grimaldi.

Office Hours and Place: Wednesday at 1:00 in 103 Skiles (additional office hours may be necessary in the future).

Grade Calculation: Your grade will be based on your performance on the homeworks, each of the two midterms, and then the final. Your grade will be computed according to the following weighting: 30% from homeworks, 20% from each of your two midterms, and 30% from the final exam. Your letter grade will be based on the usual 60-70-80-90 scale (90 and higher is an A, 80 to 90 a B, and so on).

Homeworks: I will collect homeworks every two weeks (except for the first one – maybe it will get collected on the third week.) Typically, I will ask the grader to grade some problems for accuracy, and the rest for effort. This is why it is best to work all the homeworks – if you leave some out, and they happen to be the ones graded for accuracy, your grade will suffer.

Missed Exams and Homeworks: If you miss a midterm, I will not give you a makeup. Instead, I will work out some fair way to re-weight your grade, based on the performance on your other exams. If you miss the final, however, and present a valid excuse, I will likely give you a makeup final exam.

In either case, you must present a documented reason for missing the exam if you expect to have a grade on another test to substitute. Doctor's notes and funeral notices are good examples of the documentation I am looking for.

Honor Code: Please review the Georgia Tech honor code. All students are expected to comply with the Georgia Tech Honor Code. Any evidence of cheating or other violations of the Honor Code will be reported (in fact, I did this last year, and I can tell you that it is a long, unpleasant process for the accused and accuser alike).

Course Syllabus

Professor: Dr. Christine Heitsch

Office: Skiles 244

Phone: (404) 894 - 4758

Email: heitsch@math.gatech.edu

Webpage: <http://www.math.gatech.edu/~heitsch>

Office Hours: Tuesday and Thursday 11AM – 12PM. If you need to see me at another time, please email me to set up an appointment.

Lectures: Tues, Thurs 9:35 – 10:55 in Skiles 268.

Textbook: Ralph P. Grimaldi, *Discrete and Combinatorial Mathematics*, Fifth edition, Addison-Wesley, 2003.

Course Description: “Elementary combinatorial techniques used in discrete problem solving: counting methods, solving linear recurrences, graph and network models, related algorithms, and combinatorial designs.”

Course Topics: Principles of Counting (Chapt. 1); Properties of the Integers: Mathematical Induction (Chapt. 4); Relations and Functions (Chapt. 5); The Principle of Inclusion and Exclusion (Chapt. 8); Generating Functions (Chapt. 9); Recurrence Relations (Chapt. 10); An Introduction to Graph Theory (Chapt. 11); Trees (Chapt. 12).

Grading Scheme: Grades will be calculated according to the following distribution:

30% Final Exam

60% Three Midterm Exams (20% + 20% + 20%)

10% Homework

Significant improvement over the semester will also be taken into account. Grades will be assigned on the traditional scale:

A 90 or higher

B 80 – 89

C 70 – 79

D 60 – 69

F Below 60

Final Exam: The final exam is scheduled for Thursday, May 3rd, in the morning from 8:00AM - 10:50 AM. The exam will be cumulative and count for 30% of the final grade.

Midterm Exams: There will be three in-class exams, each counting for 20% of the final grade, for a total of 60%. The exams will be closed book, closed notes, no calculator, individual tests. The **tentative** exam dates are:

Midterm 1 Thursday, February 1st

Midterm 2 Thursday, March 1st

Midterm 3 Thursday, April 5th

Exam dates will be confirmed at least a week in advance.

Homework: Homework will be assigned on a weekly basis, and typically due on Thursdays at the beginning of class. Late homework will not be accepted. Selected problems will be graded; assignments should be neat and clear. Unfortunately, illegible solutions will receive no credit. Collaboration is allowed (and explicitly encouraged) when working on homework problems, but each student must write-up and submit an independent solution in his/her own words.

Attendance: Regular attendance is expected. Exceptions will be accommodated only for valid, documented reasons including (1) official representation of the Institute and (2) medical emergencies.

Note: If you will not be able to meet the requirements of the class as stated, you must contact me within the first two weeks of class.

Academic Integrity: Students are reminded of the obligations and expectations associated with the Georgia Tech *Academic Honor Code* and *Student Code of Conduct*, available online at: http://www.deanofstudents.gatech.edu/integrity/policies/honor_code.php and <http://www.deanofstudents.gatech.edu/codeofconduct>. Any violations must be reported to directly to the Dean of Students.

Additional Resources:

- WebCT — <http://webct.gatech.edu>
- 3012D webpage — <http://www.math.gatech.edu/~heitsch/3012d.html>
- Math Lab — <http://www.math.gatech.edu/academic/undergraduate/mathlab.html>
- Tech Tutoring — <http://www.undergradstudies.gatech.edu/supportTutoring.htm>

Updates: This syllabus is subject to modification. Any changes will be announced in class and posted on the course website.

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Office: Skiles 244

Phone: (404) 894 - 4758

Email: heitsch@math.gatech.edu

Webpage: <http://www.math.gatech.edu/~heitsch>

Office Hours: Tues 11AM – 12PM and Thurs 1:30 – 2:30. If you need to see me at another time, please email me to set up an appointment.

Lectures: Tues, Thurs 12:05 – 1:25 in Skiles 254.

Textbook: Ralph P. Grimaldi, *Discrete and Combinatorial Mathematics*, Fifth edition, Addison-Wesley, 2003.

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10% Homework

Significant improvement over the semester will also be taken into account. Grades will be assigned on the traditional scale:

A 90 or higher

B 80 – 89

C 70 – 79

D 60 – 69

F Below 60

Final Exam: The final exam is scheduled for Tuesday, Dec. 12th, in the morning from 8:00AM - 10:50 AM. The exam will be cumulative and count for 30% of the final grade.

Midterm Exams: There will be three in-class exams, each counting for 20% of the final grade, for a total of 60%. The exams will be closed book, closed notes, no calculator, individual tests. The **tentative** exam dates are:

Midterm 1 Tuesday, Sept. 12th

Midterm 2 Tuesday, Oct. 10th

Midterm 3 Tuesday, Nov. 7th

Exam dates will be confirmed at least a week in advance.

Homework: Homework will be assigned on a weekly basis, and typically due on Tuesdays at the beginning of class. Late homework will not be accepted. Selected problems will be graded; assignments should be neat and clear. Unfortunately, illegible solutions will receive no credit. Collaboration is allowed (and explicitly encouraged) when working on homework problems, but each student must write-up and submit an independent solution in his/her own words.

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Additional Resources:

- 3012F webpage — www.math.gatech.edu/~heitsch/3012f.html
- Math Lab — <http://www.math.gatech.edu/academic/undergraduate/mathlab.html>
- Tech Tutoring — <http://www.undergradstudies.gatech.edu/supportTutoring.htm>

Updates: This syllabus is subject to modification. Any changes will be announced in class and posted on the course website.

MATH 3012 SYLLABUS

Spring 2002

Instructor: Klara Grodzinsky

Office: Skiles 248, 404-894-4397 (or leave a message at 404-894-2700)

Office Hours: Monday and Wednesday, 1:00-2:30 pm; Friday, 9:00-9:45 am; and by appointment

E-mail: grodzinsky@math.gatech.edu

Web Page: <http://www.math.gatech.edu/~kcohn>

Course Title: Applied Combinatorics

Text: Grimaldi, *Discrete and Combinatorial Mathematics*, 4th ed. We will cover most of chapters 1, 4, 5, and 8-12.

GRADING SYSTEM

HOMEWORK: Homework will be assigned at the end of each lecture. You are expected to understand **all** homework problems for the tests. Homework will be collected and graded every Monday during the semester (except on test weeks), beginning on **Monday, January 14**.

TESTS: There will be three (3) 50-minute tests, administered on the following Mondays: **February 4, March 18, and April 15**.

No written make-up tests will be allowed. In *extreme* circumstances, I will allow an oral make-up test with a **written, reasonable** excuse and **prior notice** of your absence. No make-ups will be granted after the tests have been graded.

FINAL EXAM: The final exam will cover all course materials and will be administered on the date assigned by the official school calendar. You **MUST** take the final exam on the officially scheduled date, so **do not make travel plans** during final exam week until the official final exam schedule is announced. (The *tentative* date is Tuesday, April 30.)

GRADING SCALE

Homework	15%
Tests	55%
Final Exam	30%
TOTAL:	100%

You will be guaranteed a minimum of the following scale:

A: [90%, 100+%]; **B:** [80%, 90%]; **C:** [70%, 80%]; **D:** [60%, 70%]; **F:** [0%, 60%).

CLASS POLICIES

ATTENDANCE: You are expected to come to class **prepared** and actively participate in the lecture. In the event of an absence, you are responsible for all missed materials, assignments, and any additional announcements or schedule changes given in class.

ACADEMIC DISHONESTY: All students are expected to comply with the Georgia Tech Honor Code.

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REGRADE OF PAPERS: If a problem on your test has been graded in error, you must submit a regrade request to me **in writing**, along with your paper, no more than *one week* after the tests have been returned in class. Should you wish to have your paper regraded, *do not change or add to the work on your paper!* If you must write on your returned paper, be sure to write in a different color ink and clearly indicate what you have added. A regrade request can only be submitted if you have done something **CORRECT** on your test that has been marked as incorrect. You **MUST** check your answers with the solutions **BEFORE** submitting such a request. Failure to comply with these rules will result in a **LOWER** grade.

WORLD WIDE WEB: I will frequently update the class web page with class information and materials. In addition, the solutions to all tests will be placed on reserve in the library (www.library.gatech.edu).

TENTATIVE COURSE SCHEDULE

TOPIC	APPROX. # OF LECTURES
Notation and Proofs (notes, 2.5)	3
Fundamental Principles of Counting (1.1-1.4)	4
Mathematical Induction, Number Theory (4.1-4.5)	6
Relations and Functions (5.1, 5.2, 5.3, 5.5)	3
Inclusion-Exclusion (8.1-8.5)	6
Generating Functions (9.1-9.5)	5
Recurrence Relations (10.1-10.4)	4
Introduction to Graph Theory (11.1-11.6)	6
Further Topics in Graph Theory (Chapter 12)	3
TOTAL:	40

Course Outline: 3012 T – Applied Combinatorics
(Classroom: Skiles 268, 4:35pm – 5:55pm)

Instructor : Prasad Tetali, office: Skiles 234, email: tetali@math.gatech.edu

Office Hours: Mon. 1:30 – 3:00pm, Thurs. Fri. 2:00–3:00pm (tentative).

PLEASE MAKE SURE THAT YOU ARE IN THE CORRECT SECTION!

Text book: *Discrete and Combinatorial Mathematics (fifth edition)*, by Ralph P. Grimaldi.

Syllabus: Chapters 1, 4, 5, 8 – 12 and time permitting : parts of Chapters 13, 17
I anticipate spending roughly one week on each chapter, excepting Chapters 1, 10, and 11, which might take two weeks each.

Course Objectives. To introduce principles of counting, teach problem solving techniques, and develop a background in discrete mathematics.

There will be THREE quizzes in addition to TWO tests and a FINAL exam. Quizzes will be announced at least one class before they happen. *No make-up tests will be allowed.*

Test 1: Monday, Sept. 17th, **Test 2:** Monday Nov. 5th

There will be a homework every week. Late homeworks are penalized by 20% deduction of credit. You are advised to solve as many problems as you can; that is the only way to learn this material well.

General grading policy: HWs 20%, Three Quizzes 20%, Two Tests 30%,
Final Exam 30%

Suggestions:

- Please feel free to ask questions any time: before, after or during the class.
- Try to make use of my office hours; special appointments can be made.
- Please work on homework problems alone.
- Please hand in **legible** answer sheets **on time**.

FALL 2007: MATH 3012 (Applied Combinatorics)

This section is titled 3012 T, where T is a code the scheduler uses for bookkeeping that the class meets laTe in the afternoon!

[Click here for an outline](#)

Turn in solutions to only the EVEN numbered problems in ALL HWs.

HOMEWORK 1 (Due: Wednesday, August 29th) :

Sections 1.1-1.2 (pages 11-14): Problems 4, 9, 19, 20, 30, 31

Sections 1.3 (pages 24-26): Problems 3, 4, 5, 8, 11, 17, 20, 21, 25, 26, 30

HOMEWORK 2 (Due: Monday, September 10th) :

Sections 1.4 : Problems 4, 7, 10, 12, 13, 17, 23, 27

Sections 1.5 : Problems 9, 10

Sections 4.1 : Problems 2, 4, 7, 14, 15, 19

QUIZ 1 on Sept. 10th in class -- syllabus: Chapter 1.

[Click here for a sample quiz](#)

[Quiz 1 with solutions](#)

HOMEWORK 3 (NO NEED TO TURN IN):

Sections 4.3 : Problem 8

Sections 4.4 : Problems 1, 3, 11, 14, 15, 21

Supplementary exercises (Ch. 4) : Problems 11, 17, 19, 20

[Solns. to HWs 2 and 3](#)

TEST 1 on Sept. 17th in class -- syllabus: Chapters 1, 4.

[Solns. Test 1](#)

HOMEWORK 4 (Due : Monday, October 1st):

Sections 5.1 : Problem 10

Sections 5.2 : Problems 2, 3, 15, 22, 26, 27

Sections 5.3 : Problems 2, 4, 5, 6, 10, 15, 18

[Solns. to HW 4](#)

QUIZ 2 on Oct. 15th (Monday) in class -- syllabus: Chapters 5, 8.

(Sections 5.1, 5.2, 5.3, 5.5, and 8.1 on Quiz 2)

[Quiz 2 with solutions](#)

HOMEWORK 5 (Due : Monday, October 15th):

Sections 5.5 : Problems 3, 7, 10, 14, 18, 20, 24

Sections 8.1 : Problems 4, 6, 10, 11, 17, 18

HOMEWORK 6 (Due : Wednesday, October 24th):

Sections 11.3 : Problems 12, 13, 20, 23, 24, 26, 36

Sections 11.4 : Problems 2, 5, 11, 14, 16, 18, 19, 21, 26

NOTE : TEST 2 on Nov. 5th (Monday) in class --

Syllabus: Chapter 11 (all sections, EXCEPT 11.5) and Sec. 12.1; OPEN NOTES

HOMEWORK 7 (NO NEED TO SUBMIT):

Sections 11.6 : Problems 7, 9, 13, 15, (3 done in class)

Chapter 11 (Supplementary exercises) : Problems 3, 5, 8

<http://people.math.gatech.edu/~tetali/TEACH/Math3012.html>

Fri Jul 20 14:56:06 2012

Chapter 11 (Supplementary exercises) : Problems 3, 5, 9

Sections 12.1 : Problems 5, 7, 9, 14, (21 done in class), 23, (24 will be done in class)

Solution to 12.1.14: Answer is floor of $(n+1)/2$:

* First note that each spanning tree of $K_{2,n}$ has degrees (a,b) on one side and $(1,1,\dots,1,2)$ on the other side, where in the first list $a+b=n+1$ (with a, b positive integers), and the second list has $(n-1)$ 1's and one 2 -- if there are two 2's on the second list, there will be a cycle.

* Now easy to see that the number of unordered choices for (a,b) is the floor of $(n+1)/2$, namely, $(1,n), (2,n-1), \dots, (\text{floor}\{n+1/2\}, \text{ceil}\{n+1/2\})$

HOMEWORK 8 (Due: MONDAY/TUESDAY, NOV. 19/20th):

Sections 9.1 : Problems 2, 4

Sections 9.2 : Problems 13, 14, 15, 16, 18

Sections 9.4 : Problems 2(b, f), 4(a, b), 9, 10

*** NOTE : QUIZ 3 on Nov. 28th (Wednesday) in class --

*** Syllabus : Sections 9.1, 9.2, 9.4, and Sections 10.1, 10.2, 10.3

(OPEN NOTES for QUIZ 3)

NOTE: Office hours from Nov. 26th onwards: Mon, Tue, Wed : 1:30--2:30pm

*** NOTE: AS announced in class, the final is OPEN NOTES AND OPEN TEXTBOOK! ***

Math 3012 F: Applied Combinatorics

Fall 2011

T - Th 12:05 - 13:25

Skiles 202

- **Text:** The text for this course is [Applied Combinatorics](#) by Keller and Trotter. It is available without cost on-line and students are encouraged to download the entire file to their computers. This text has been under development for the past seven years and is a joint project between Professor Trotter and Mitchel T. Keller, who completed his Ph. D. in spring 2010 at Georgia Tech, with Professor Trotter serving as his thesis advisor. Mitch won a prestigious Marshall Sherfield postdoctoral fellowship and is now in the Department of Mathematics of the London School of Economics. This text has specifically written with Georgia Tech students and Math 3012 as targets. Although it is a mathematics text, it has computer science and engineering concepts, principles and applications close to the surface.
- **Outline of Topics:**
 1. **Discrete Structures:** Graphs, digraphs, networks, designs, posets, strings, patterns, distributions, coverings, partitions.
 2. **Enumeration:** Permutations, combinations, inclusion/exclusion; generating functions; recurrence relations, Polya counting.
 3. **Algorithms and Optimization:** Sorting, spanning trees, shortest paths, eulerian circuits, hamiltonian cycles, graph coloring, planarity testing, network flows, bipartite matchings, chain partitions.
- **Classes meet:** Skiles 202, Tuesdays and Thursdays, 12:05 -13:25. Please be on time and ready to learn.
- **Grading Scale:** Grades will be assigned on the traditional scale:

A	90 or higher
B	80 - 89
C	70 - 79
D	60 - 69
F	Below 60

- **Grading Policy:** Grades will be determined by the following distribution:

60%	Three in semester tests
10%	Homework, quizzes and projects
30%	Final Exam

- **Tests:** There will be three tests during the term, each counting 20% of the final grade, i.e., altogether, these three tests will count for 60% of the final grade.
- **Homework, Quizzes and Projects:** 10% of the final grade will be determined by homework, in-class quizzes and an optional project. Students are strongly encouraged to collaborate with other students on homework problems but must write up their solutions independently.
- **Final Exam:** The final exam will be cumulative and will count for 30% of the final grade.
- **Computing element:** This course is a math course. But combinatorics is closely related to computer science, and students will be required to use and understand computer programs developed for this course. On the other hand, no prior programming knowledge is assumed.
- **Attendance:** Students are expected to attend all lectures without exception. Make-up exams will be given only for (1) official representation of the Institute, and (2) documented medical emergencies requiring hospitalization. Notice of being seen at the Student Health Center is **not** accepted as documentation.
- **Student Support:** Professor Trotter holds regularly scheduled office hours, and students are strongly encouraged to drop by for help. Come sooner rather than later. Experience shows that some Georgia Tech students are reluctant to ask for help as if something they never had to do in high school. Don't fall

Tech students are reluctant to ask for help as if something they never had to do in high school. Don't fall into this trap. The School of Mathematics wants every student to succeed and we will help you if you make the effort.

- **Academic Integrity:** Students are reminded of the obligations and expectations associated with the Georgia Tech *Academic Honor Code* .

Updated August 19, 2011.

