

Syllabus for MATH 3533, Combinatorial Mathematics

Northeastern University, Summer 2 2015

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Office hours: Tuesdays and Wednesdays, 1 pm – 2.30 pm, or by appointment.

Meeting times and location: MTWR, 9.50 am – 11.30 am at Shillman Hall 315.

This course deals with principles and techniques for counting, applied to a variety of problems. Techniques include permutations, combinations, generating functions, inclusion-exclusion, recurrence relations, etc. This is a problem-solving course, with many diverse problems. Our task will be to figure out the underlying form or type of the problem and then apply the relevant principles or techniques. A good solution to a problem is one that explains and justifies your reasoning and any computations you make. Combinatorial reasoning is useful in fields including computer science, operations research, probability and statistics, etc. The way to acquire the problem solving skill is to do many, many exercises. There is no substitute!

Textbook: *Introductory Combinatorics* by Richard A. Brualdi (fifth edition).

Web Materials: All class announcements, material, and grades will be posted on Blackboard.

Homework: Homework will be assigned, but will NOT be collected.

Tests: There will be 4 in-class tests and 2 take-home tests during the semester.

Test 1: July 16 (in-class)

Test 2: July 23 (in-class)

Test 3: July 30 (in-class)

Test 4: August 6 (in-class)

Test 5: August 11 (take-home, due on August 13)

Test 6: August 17 (take-home, due on August 19)

It is strongly advised that you do all of assigned homework since the tests will closely resemble the homework problems. There will be NO make-up tests.

Final exam:

The final exam is cumulative. Date and location of the final exam are to be determined. **Check for exam schedule conflicts as soon as possible.** Only two finals at the same time or three in one day is a University recognized legitimate reason to be excused from taking the final at the scheduled time. Students with such a conflict should complete a final exam conflict form, available on the registrar's website.

Grading: The course grade will be determined as follows:

Final exam: 25%

Tests: 75%

Letter grades are determined numerically:

$A \geq 93$, $92 \geq A- \geq 90$, $89 \geq B+ \geq 87$, $86 \geq B \geq 83$, $82 \geq B- \geq 80$,
 $79 \geq C+ \geq 77$, $76 \geq C \geq 73$, $72 \geq C- \geq 70$, $69 \geq D+ \geq 67$, $66 \geq D \geq 63$,
 $62 \geq D- \geq 60$, $F \leq 59$

The grade I (Incomplete) will be given only if you have a good attendance record, have missed the final exam for a good reason, and otherwise are doing passing work. An incomplete is given at the discretion of the instructor.

Additional Resources: The Mathematics Department Tutoring Center is in Room 540B, Nightingale Hall. This peer tutoring is free. Peer Tutoring appointments can be booked via MyNEU under TUTORING. Although you can walk in, it is really best to sign up in advance. Tutoring requests are scheduled by students in real-time and confirmed by email. Next-day appointments must be booked by 9:00 pm the previous day. Tutoring services in the Mathematics Department Tutoring Center will begin on July 7. See <http://www.northeastern.edu/csastutoring/setting-up-appointments/> For more information about peer tutoring.

Issues with the course/instructor: If you have issues with this course and/or instructor which you are not comfortable discussing with your instructor, you should contact the Teaching Director, Prof. Massey, at d.massey@neu.edu.

Academic Honesty: Collaboration on quizzes, tests and final exam is not allowed. From Student Code of Conduct (see <http://www.northeastern.edu/osccr/academicintegrity/>): "A necessary prerequisite to the attainment of the goals of the University is maintaining complete honesty in all academic work. Students are expected to present as their own only that which is clearly their own work in tests and in any material submitted for credit. Students may not assist others in presenting work that is not their own. ... Offenders are subject to disciplinary action." For more on Academic Integrity see: <http://www.northeastern.edu/registrar/courses/cat1213-univ-proc.pdf>

Note the Following Dates:

July 19, is the last day to drop a Summer 2-15 class without a W grade

July 20, is the last day to elect pass/fail for Summer 2-15 class

July 28, is the last day to file a Final Exam Conflict Form for Summer 2-15 classes

August 7, is the last day to drop a Summer 2-15 class with a W grade

Important:

- 1) Any student with a disability is encouraged to meet with the instructor during the first week of classes to discuss accommodations. The student must bring a current Memorandum of Accommodations from the Disability Resource Center (DRC).
- 2) If you are an athlete and have conflicts with an important class activity (quiz, mid-term, or final), you should let your instructor know before the end of second week of classes. You should also bring an official letter from the Office of Athletics.
- 3) All electronic devices (mobile phones, laptops etc.) should be turned off during class time, quizzes, tests and final exam.

Syllabus: Syllabus is subject to change. It is your responsibility to be aware of any changes the instructor may make to the syllabus as they are announced in class. Students are responsible for all information given when they are absent

TRACE: Please complete the TRACE evaluations at the end of the course.

Schedule of Topics

Week 1: July 6 – 10

- 2.1 Four Basic Counting Principles
- 2.2 Permutation of Sets
- 2.3 Combinations of Sets
- 2.4 Permutations of Multisets
- 2.5 Combinations of Mutisets

Week 2: July 13 – 17

- 3.1 Pigeonhole Principle
- 3.3 A Theorem of Ramsey
- 5.2 The Binomial Theorem

Week 3: July 20 – 24

- 5.3 Unimodality of Binomial Coefficients
- 5.4 The Multinomial Theorem
- 4.5 Partial Orders and Equivalence Relations
- 5.6 More on Partially Ordered Sets

Week 4: July 27 – 31

- 6.1 The inclusion-Exclusion Principle
- 6.2 Combinations with Repetition
- 6.3 Derangements
- 6.4 Permutations with Forbidden Positions

Week 5: August 3 – 7

- 6.6 Mobius Inversion
- 7.1 Some Number Sequences
- 7.2 Generating Functions
- 7.3 Exponential Generating Functions

Week 6: August 10 – 14

- 7.4 Solving Linear Homogeneous Recurrence Relations
- 7.6 A Geometry Example
- 8.1 Catalan Numbers
- 8.2 Difference Sequences and Stirling Numbers

Week 7: August 17 – 21

- 8.3 Partition Numbers
- 8.4 A Geometric Problem
- 8.5 Lattice Paths and Schroder Numbers (if time permits)
- Review

August 24 - August 25 final exams