

Math 532 – Combinatorial Analysis

3.0 Units Fall 2020 MWF 12:00–12:50pm

Location: Online

Instructor: Sami Assaf

Office Hrs: By appointment

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Teaching Assistant: TBD

Office Hrs: TBD

Contact: TBD

Course Description

This course surveys a variety of topics in Combinatorics from an analytical viewpoint, including basics of enumeration, sieve methods, inversion formulas, and generating functions. Emphasis is placed on the quintessential examples of sets, cycles, and partitions that often arise in applications coming from physics, computer science, and statistical mechanics as well as branches of mathematics including probability, representation theory, and geometry.

Learning Objectives

By the end of the course, students will develop proficiency doing the following:

- compute examples from combinatorial descriptions;
- recognize common combinatorial objects, patterns, and recurrence relations;
- prove and/or derive formulas using generating function techniques;
- construct bijections between equinumerous objects.

In addition, students will develop proficiency in creating L^AT_EX documents.

Course Notes

Course lectures will be delivered asynchronously via Blackboard in the form of pre-recorded videos of approximately 10 minutes in duration. Lecture notes for each video will be included in PDF format. Each video will be followed by a short self-assessment.

Course meetings will happen synchronously via Zoom and will be recorded for asynchronous viewing. Synchronous meetings include questions, taken live or as sent via email prior to the meeting, and discussion. Students are expected to engage actively in synchronous sessions.

Technological Proficiency and Hardware/Software Required

Students are expected to have computer and internet access.

Required Readings and Supplementary Materials

Required: *Enumerative combinatorics*, volume 1, second edition, by Richard Stanley.

Description and Assessment of Assignments

The course material is divided into 5 modules, with each module divided into 5 topics. Each topic is followed by a multiple choice assignment to assess computational skills. Each module has a problem set due one week after the conclusion of the module.

Grading Breakdown

Computational problems and typed problem sets will each account for 50% of the grade.

Assignment Submission Policy

Multiple choice computational problems must be completed within Blackboard prior to the end date for the module to which they are attached.

All problem sets for the course must be formatted in L^AT_EX and submitted via blackboard. Templates will be provided for each assignment, with macros to assist in creating figures.

Course Schedule

Module 1 - Basics of Counting: types of enumeration; counting sets; counting cycles; counting partitions; counting maps (the 12-Fold Way).

Module 2 - Refined Counting Techniques: inversion; descents; alternating permutations; permutations of multisets; pentagonal number theorem.

Module 3 - Sieve Methods: Examples; Inclusion–Exclusion; restricted permutations; Ferrers boards; involution principle.

Module 4 - Posets: partially ordered sets; lattices; distributive lattices; Möbius inversion; Möbius functions.

Module 5 - Generating Functions: binomial posets; rational power series; information extraction; polynomial generating functions; magic squares.

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism presenting someone else's ideas as your own, either verbatim or recast in your own words is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* <https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct/>.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* <http://equity.usc.edu/> or to the *Department of Public Safety* <http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us>. This is important for the safety of the whole USC community. Another member of the university community such as a friend, classmate, advisor, or faculty member can help initiate the report, or can initiate the report on behalf of another person. The *Center for Women and Men* <http://www.usc.edu/student-affairs/cwm/> provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* <http://dornsife.usc.edu/ali>, which sponsors courses and workshops specifically for international graduate students. The *Office of Disability Services and Programs* http://sait.usc.edu/academic-support/center-programs/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* <http://emergency.usc.edu/> will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.