Math 432 – Applied Combinatorics

4.0 Units   Spring 2021   MWF 2:00-2:50pm

Location: Online

Instructor: Sami Assaf	**Teaching Assistant:** TBD
Office Hrs: Monday, Tuesday 3-4pm	**Office Hrs:** TBD
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Course Description

This course surveys a variety of topics in combinatorics, beginning with basic counting techniques (e.g. Pigeonhole Principle) and elementary proof techniques (e.g. mathematical induction, counting in two ways). We apply these to enumeration of subsets, arrangements, and derangements. We develop advanced counting techniques of generating functions and solving recurrence relations. We study fundamentals of graph theory and algorithms on graphs, including graph colorings and matchings. We also explore advanced topics in probabilistic methods.

Learning Objectives

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

- compute examples from combinatorial descriptions;
- recognize common combinatorial objects, patterns, and recurrence relations;
- equate real world scenarios with graph-theoretic problems;
- develop proficiency applying combinatorial algorithms.

Prerequisite(s): MATH 225 or MATH 226 or MATH 227

Course Notes

Course lectures will be delivered in asynchronously via pre-recorded videos to introduce new topics. Each class day will feature 3 recorded mini-lectures, each approximately 5-8 minutes, available one week in advance. Students are expected to view the recordings *prior to the live session.*

Course meetings will occur synchronously via Zoom and will be recorded for asynchronous viewing. Synchronous meetings include examples, applications and discussions. Students are expected to engage actively in synchronous sessions. After each live session, lecture notes will be posted online for students to access.

Technological Proficiency and Hardware/Software Required

Students are expected to have computer and internet access.

Required Readings and Supplementary Materials

Required: Miklós Bóna, *A Walk Through Combinatorics*, 3rd edition.
Recommended: Donald Knuth, *The Art of Computer Programming, Volume 4A*

Description and Assessment of Assignments

Students will complete weekly problem sets that reinforce and expand on topics covered in lecture. There will be 12 problem sets throughout the term, each with 6 problems worth 3 points apiece. Full homework points for the term is 180 total points (5 problems per week). There will be three in-class midterms, on Feb 5, March 5 and April 2, and a final on Monday May 10 from 2-4pm.

Any student found to plagarize a homework problem or exam problem from any source will receive an F for this course and a report will be filed with SJACS.

Grading Breakdown

Assignment	% of Grade
Homework (12 assignments)	45%
Midterm I (Fri 2/05)	10%
Midterm II (Fri 3/05)	10%
Midterm III (Fri 4/02)	10%
Final Exam (Fri 5/10)	25%
TOTAL	**100%**

Assignment Submission Policy

Homework must be submitted via Blackboard on or before the due date. Solutions will be posted immediately after the due date, and so **late homework is not accepted**.

Course Schedule by Topics

Lectures	Topics Covered	Readings	Deliverable/Due Dates
1/15, 1/20, 1/22	Counting Basics	Ch 1 & 2	Homework 1 (due 1/25)
1/25, 1/27	Orders and Choice	Ch 3	Homework 2 (due 1/29)
1/29, 2/01, 2/03	Binomial Theorem	Ch 4	Homework 3 (due 2/05)
2/05			Midterm I (in class 2/05)
2/08, 2/10,2/12	Partitions	Ch 5 & 6	Homework 4 (due 2/17)
2/17, 2/19, 2/22	Permutations	Ch 7	Homework 5 (due 2/24)
2/24, 2/26, 3/01	Generating functions	Ch 8	Homework 6 (due 3/03)
3/03, **3/05**			Midterm II (in class 3/05)
3/08, 3/10, 3/15	Graph theory	Ch 9	Homework 7 (due 3/17)
3/17, 3/19, 3/22	Trees	Ch 10	Homework 8 (due 3/24)
3/24, 3/26, 3/29	Graph Coloring	Ch 11	Homework 9 (due 3/31)
3/31, **4/02**			Midterm III (in class 4/02)
4/05, 4/09, 4/12	Ramsey Theory	Ch 13	Homework 10 (due 4/14)
4/14, 4/16, 4/19	Discrete Probability	Ch 19	Homework 11 (due 4/21)
4/21, 4/23	Card Shuffling		Homework 12 (due 4/28)
4/26, 4/28, **5/10**			Final Exam (in class 5/10)

Statement on Academic Conduct and Support Systems

Academic Conduct
Plagiarism presenting someone elses 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 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 USCs 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/academicsupport/centerprograms/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.