MATH 268, Spring 2020: Combinatorics and Graph Theory

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Class Meetings

Mondays, Wednesdays, Fridays: 2:20 PM - 3:20 PM in Trexler 374

Office Hours

By appointment only (see https://saoub.youcanbook.me), mainly during the times listed below.

Mondays, Wednesdays, Fridays	1:15 – 2:00 PM
Tuesdays, Thursdays	11:00 – 12:00 PM

About the Course

This course consists of two distinct though related concepts in discrete mathematics combinatorics and graph theory.

The first third of the course surveys main topics in combinatorics, which is the study of counting discrete structures. Combinatorics provides practice with precision in arguments, organizing information into an equation, and writing proofs.

The last two-thirds of the course surveys main topics in graph theory. These will include (but are not limited to) graph routes, trees, connectivity, matching, coloring, and planarity. Graphs provide practice with modeling a problem using a mathematical structure, organizing information so a solution can be found, and writing proper mathematical proofs.

Intended Learning Outcomes

By the end of this course, successful students will be able to construct valid proofs that proceed efficiently from hypothesis to conclusion; identify properties of graphs; analyze problems to construct appropriate graph theoretic models; analyze counting problems to identify appropriate solution techniques; and present solutions orally and in writing.

Required Materials

Online Resource: *Combinatorics* by Joy Morris
(available at http://www.cs.uleth.ca/~morris/Combinatorics/Combinatorics.pdf) Textbook: *Graph Theory: An introduction to Proofs, Algorithms, and Applications* by
Karin Saoub (pre-print available at cost in class)
Other: basic calculator
All work should be completed neatly in pencil or typed.

Course Grades

The following table lists the weights for the various forms of assessment for this class.

Problems Sets	24%
Combinatorics Presentation	4%
Graph Theory Presentation	4%
Applications Presentation	8%
Tests (14% each)	42%
Final Exam	18%

A grade scale will be determined after final grades are computed, but will be no worse than the scale given below. Attendance and class participation will be considered when determining marginal grades.

		B+	87-89	C+	77-79	D+	67-69		
A	94-100	B	83-86	C	73-76	D	63-66	F	0-59
A-	90-93	B-	80-82	C-	70-72	D-	60-62		

Expected Work Hours

This course expects you to spend at least 12 hours of work each week inside and outside of class.

Academic Integrity

Students are expected to adhere to the Academic Integrity policies of Roanoke College. All work submitted for a grade is to be your own work! Collaboration is required on presentations and permitted on homework. However, all homework solutions should be written up separately - you cannot simply copy a classmate's work or trade answers. Additional instructions will be provided on all tests and exams.

Cell phones must be turned off prior to entering the classroom. Laptops may be used for note-taking during regular class sessions, if this seems useful to you, but you may not log on to the internet or to an email server unless specifically told to do so. The use of laptops and other electronic devices, except for a calculator, during an exam is strictly prohibited. This includes tablets, smart phones, and iPods. Any use of such devices during a quiz or exam will be considered a breach of academic integrity. Note that looking at or using your cell phone during a test or quiz is considered a violation of Academic Integrity regardless of your purpose or intent in doing so.

Reading and Participation

The key to learning a topic in mathematics is participation. We will strive to have an active, rather than passive, classroom environment. The last page of the syllabus is a day by day outline of the sections that will be discussed in class (this is subject to change as needed). You are fully expected to have read the upcoming section **before** the class meeting!

Problem Sets

A problem set will be due each week (excluding week 12) as shown on the schedule on the last page. These will be assigned the previous week and each are worth a total of 25 points. There are three parts to each problem set. The first part is worth 7 points and will be graded based on effort and completeness. This part consists of the three daily homework assignments for the previous three class periods. Daily homework will include more computational type problems and you are welcome to ask questions about them at the beginning of class. The second part of each problem set is worth 16 points and will be graded based on correctness and presentation. Each week you will complete 4 problems, worth 4 points each, which will be carefully graded for correctness and completion of the solution. The third part of the problem set, worth 2 points, is for presentation of the problems.

When you turn in your problem sets, make sure the four problems graded for correctness are on top and then below are your three daily assignments. Your homework should be neat, organized, and stapled. You can collaborate on problem sets but you must write up your own solution. If you are looking at another person's work when you are writing up your problem set, then you are in violation of the academic integrity policy of Roanoke College.

If you will be absent, turn in your homework before the class period it is due, or have a friend turn it in for you. Late homework will only be accepted within 2 days of the original due date and will automatically lose the completion points.

Presentations

You will be responsible for presenting some of the material in this class. You should not start on the presentation the night before it is due! These will focus on more in-depth proofs, interesting problems, or puzzles not previously introduced to the class. Students will be in small groups (around 3 students per group). There will be two different types of presentations: topic based and application based.

For the topic based presentations, groups will give 5-8 minute presentations closely related to the material we have been studying recently. The first round of presentations will be

combinatorics based and occur at the end of the combinatorics portion of the course. The second round of presentations will be split amongst various days in the graph theory portion of the course, and will provide additional insight into topics recently covered in class.

For the application based presentation, each group will present on an application of graph theory. These presentations should outline not only the way in which graph theory is used to answer a question, but also provide an example of its use. These will be 10-15 minutes in length and encompass two days of class time at the end of the semester. A presentation proposal will be due April 1.

Tests

Three in-class tests will be given, roughly according to the schedule on page 5. Each test will focus on material from the most recent chapters studied. However, as with most mathematics classes, each test will require you to understand and remember things from the past.

Final Exam

The Final Exam is cumulative (covering both Combinatorics and Graph Theory) and will be more proof heavy than the in-class exams. Specific instructions will be given with the final exam regarding outside help. The Final Exam will be distributed at the end of Test 3 and is due by 2PM on Tuesday April 28th.

The Final Exams must be turned in on-time; a late-penalty (after grading) of $33\frac{1}{3}\%$ will be assessed per 24 hours late (rounded up); no exceptions.

Co-Curricular Engagement

The MCSP Department offers a series of talks (MCSP Conversation Series) that appeal to a broad range of interests related to these fields of study. These co-curricular sessions engage the community to think about ongoing research, novel applications and other issues that face our discipline.

Members of this class are invited be involved with all of these meetings; however participation in **at least two** of these sessions is mandatory. After attending, students will submit a one page paper reflecting on the discussion to Inquire *within one week of the presentation*. This should **not** be a regurgitation of the content, but rather a personal contemplation of the experience.

Failure to submit a reaction paper will result in a 1% reduction in your final grade. Additional events may be attended, and subsequent reflection papers may be submitted for extra credit, with .5% added to your course average for each additional attended, up to 2% total. In addition, individually you may request that other appropriate events count.

Attendance & Make-Up Work

Attendance is critical to the understanding of the material in the course; it is both required and expected. Any absence that is not discussed with the instructor prior to the missed class is considered unexcused. I will assume that if you accumulate 4 unexcused absences you are not interested in completing the course. After the 3rd unexcused absence, you, your advisor, and the registrar will be warned that another absence will result in your removal from the class (DF).

As noted above, late homework will only be accepted within 2 days of the original due date and will automatically lose the completion points. *When absent, excused or unexcused, you are responsible for all material covered in class. You will not be allowed to make up any work missed due to an unexcused absence.*

Study Room

The MCSP Study Room, Trexler 271, can be used by you and your friends to meet up so that you can work on homework together or prepare for tests. It is open virtually 24 hours a day, 7 days a week (very occasionally there are meetings in that room). Your student ID card should grant you access to Trexler Hall any time of day if the doors happen to be locked (use the card access point located by the first floor entrance facing the parking lot). Take advantage of this area and time, especially during weekdays when I am around (which is generally a lot)!

Community

Please feel free to become an active member of our department's community. Each of the three disciplines in our department has a student club and you should join! The Roanoke College Student Chapter of the Mathematical Association of America (or "Math Club" for short) meets every other week, plays and learns about games and hosts evening events and the annual Pi-Day celebration! Membership in our Math Club also grants membership into the MAA itself; one of the premiere professional mathematical organizations in the world.

In addition, our department offers a weekly tea time for students and faculty; feel free to stop by the MCSP Study Lounge (Trexler 271) for tea and cookies on Thursdays from 2:15 PM to 3:15 PM. Come meet other students as well as chat with the MCSP faculty members in a casual setting!

Accessible Education Services

(AES) is located in the Goode-Pasfield Center for Learning and Teaching in Fintel Library. AES provides reasonable accommodations to students with documented disabilities. To register for services, students must self-identify to AES, complete the registration process, and provide current documentation of a disability along with recommendations from the qualified specialist. Please contact Laura Leonard, Assistant Director of Academic Services for Accessible Education, at 540-375-2247 or by e-mail at aes@roanoke.edu to schedule an appointment. If you have registered with AES in the past and would like to receive academic accommodations for this semester, please contact Laura Leonard at your earliest convenience to schedule an appointment.

Tentative

Date	Section	Topic	Assignment

	Mon	Jan 13	2	Introduction & Product/Sum Rule	
1	Wed	Jan 15	3	Permutations & Combinations	
	Fri	Jan 17	3	Binomial Theorem	PS 1
	Mon	Jan 20	4	Bijections	
2	Wed	Jan 22	4	Combinatorial Proofs	
	Fri	Jan 24	5	Repetitions	PS 2
	Mon	Jan 27	5	Arrangements	
3	Wed	Jan 29	10	Pigeonhole Principle	
	Fri	Jan 31	10	Inclusion-Exclusion	PS 3
	Mon	Feb 3		*Combinatorics Presentations: All groups*	
4	Wed	Feb 5		**Review**	PS 4
	Fri	Feb 7		**Test 1**	
	Mon	Feb 10		Ticket to Ride	
5	Wed	Feb 12	1.1, 1.2	Introduction to Graph Theory	
	Fri	Feb 14	1.3, 1.5	Isomorphisms and proofs	PS 5
	Mon	Feb 17	2.1	Eulerian Graphs	
6	Wed	Feb 19	2.2	Hamiltonian Graphs	
	Fri	Feb 21	2.2	Hamiltonian graphs *Graph Theory Presentation: Group A, B & C*	PS 6
	Mon	Feb 24	3.1	Spanning Trees	
7	Wed	Feb 26	3.2	Tree Properties	
	Fri	Feb 28	3.3	Rooted Trees *Graph Theory Presentation: Group D & E*	PS 7
				Spring Break	
	Mon	Mar 9	4.1	Connectivity	
8	Wed	Mar 11	4.2	Menger's Theorem	
	Fri	Mar 13	4.3	Network Flow	PS 8
	Mon	Mar 16	5.1	Matching	
9	Wed	Mar 18		**Test 2**	
	Fri	Mar 20	5.2	Augmenting Paths	PS 9
	Mon	Mar 23	5.3	Stable Matching	
10	Wed	Mar 25	5.4	Factors	
	Fri	Mar 27	6.1	Graph Coloring *Graph Theory Presentation: Group F*	PS 10
	Mon	Mar 30	6.2	Graph Coloring	
11	Wed	Apr 1	6.4	On-line Coloring/Brooks' Theorem	*Proposal due*
	Fri	Apr 3	7.1	Planarity *Graph Theory Presentation: Group G & H*	PS 11

Course Schedule

	Mon	Apr 6	7.1	Kuratowski's Theorem	
12	Wed	Apr 8	7.2	Graph Coloring Revisited	
	Fri	Apr 10		**No Class** (Good Friday)	
	Mon	Apr 13		Graph Theory Summary	PS 12
13	Wed	Apr 15		*Applications Presentations: Groups A, B, C, & D*	
	Fri	Apr 17		*Applications Presentations: Groups E, F, G, & H*	
14	Mon	Apr 20		**Test 3**	
	Tue	Apr 28		**Final Exam due at 2PM**	