

Faculty of Science
Department of Mathematics and Statistics

Math 3370: Combinatorics: Techniques and Structures

Syllabus

Winter 2024

Tuesday and Thursday, 10:05-11:25 am, Chase 227 (lecture)

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people. Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Instructor Information

- **Instructor:** Isaac McMullin (he/him)
- **Office:** Chase 311 (6316 Coburg Rd)
- **Office Hours:** Tuesday and Thursday 11:35 am -12:55 pm (in my office)
- **Email:** is374247@dal.ca

When I need to communicate with the entire class, I will post an announcement on Brightspace, but email is my preferred method of contact if you have any questions. During the week, I will attempt to answer any emails within 24 hours. On the weekends I do not look at my work email and I will get back to you on the following Monday, please plan your messages accordingly. Office hours will be available to you if you have any questions about the lecture material or the assignments - Tuesdays and Thursdays after class in my office. If you are unavailable during these hours, please send me an email so we can arrange to meet at another time. In case of class cancellation, I will post an announcement on Brightspace and email the class to ensure everyone receives the message. Please check your Dal email and Brightspace page regularly for these messages.

Course Description

We introduce counting techniques and combinatorial structures and show their application and use in all branches of mathematics. Counting techniques include combinations and permutations, the pigeonhole principle, inclusion/exclusion. Other topics include recurrence relations, generating functions and power series. Structures include partial orders, set systems and transversals, and simplicial complexes.

Description of Class Format

The course is primarily face-to-face and will be taught 2 times a week for 80 minutes (Tuesday and Thursday). The class will be primarily lecture focused, though students are encouraged to raise their hands if they have any questions or concerns. Prior to each lecture, students are expected to come prepared, bringing everything they need to engage with the lecture and having done any activities from the previous class. Students are expected to attend every class.

Minimal Technical Requirements

All that will be necessary is a computer/smart phone that you can use to access the Brightspace page and a way to electronically submit assignments (some form of printer or scanner).

Course Pre-requisites, Co-requisites, Exclusions and/or other Restrictions

Pre-requisites: Math 2110 or Math 2113

Exclusions: Math 4370

Course Learning Outcomes

Upon completion of this course, students will be able to:

1. Remember theorems and definitions related to combinatorics to properly discuss them in class and use them on assignments.
2. Given a counting problem, identify how to solve it using binomial coefficients, factorials, the pigeonhole principle, inclusion/exclusion, or recurrence relations.
3. Solve problems involving matchings and recurrence relations and be able to find and recognize different kinds of partial orders, equivalence relations, and set systems.
4. Analyze mathematical statements and expressions and fully understand their conditions and results to prove or disprove their validity.
5. Relate how combinatorics, and mathematics more generally, can be used to understand and solve real-world problems; for example, how graph theory can be used to study the reliability of computer networks.
6. Come to see themselves as more skilled mathematicians and learn to inform others of the logic and structure of university mathematics.
7. Value the importance of how fields like combinatorics are built and developed, how we use axioms and definitions to build theorems, and how this method of building knowledge can be seen in the real world.

Course Materials

Textbook: Introductory Combinatorics. Richard A. Brualdi, Pearson/Prentice Hall, 5th edition, 2010.

There will be a course Brightspace page that you are expected to check daily.

Course Schedule

Week	Focus Topic	Important dates	Activities/due dates
1 Jan. 8-12	Permutations and Combinations	Jan. 8: Classes start.	
2 Jan. 15-19	Pigeonhole Principle		Assignment 1 available Jan. 18.
3 Jan. 22-26	Ramsey Theory, Partial Orders, and Equivalence Relations	Jan. 22: Last day to add/drop Winter term courses.	
4 Jan. 29-Feb. 2	Binomial Coefficients	Feb. 2: Munro Day University closed	Assignment 1 due Feb. 1. Assignment 2 available Feb. 1.
5 Feb. 5-9	Binomial Coefficients Cont.	Feb. 6: Last day to drop winter courses without a "W."	
6 Feb. 12-16	Inclusion/Exclusion		Assignment 2 due Feb. 15.
7 Feb. 19-23	Feb. 19: Nova Scotia Heritage Day - University closed Feb. 19-23: Study Break - No classes		
8 Feb. 26-Mar. 1	Recurrence Relations and Generating Functions		Midterm in class Feb. 29
9 Mar. 4-8	Recurrence Relations and Generating Functions Cont.	Mar. 6: Last day to drop winter courses with a "W."	Assignment 3 available Mar. 7
10 Mar. 11-15	Systems of Distinct Representatives		
11 Mar. 18-22	Combinatorial Design		Assignment 3 due Mar. 21 Assignment 4 available Mar. 21
12 Mar. 25-29	Graph Theory	Mar. 29: Good Friday University closed.	
13 Apr. 1-5	Graph Theory Cont.		Assignment 4 due Apr. 4
14 Apr. 8-9	No classes	Apr. 8/9: Friday classes will be held. Apr. 10: Break before exams. Apr. 11-23: Exams	

Course Assessments

Assessment	Date of Evaluation	Weight
Assignment 1	February 1, 2024	10%
Assignment 2	February 15, 2024	10%
Assignment 3	March 21, 2024	10%
Assignment 4	April 4, 2024	10%
Midterm	February 29, 2024	20%
Final Exam	TBD	40%

Assignments (40%)

Biweekly assignments will be based on the lecture material covered in the previous weeks, with 2 weeks to complete these assignments and submit them over Brightspace. The questions will involve applying knowledge from the lectures to a different context to strengthen understanding. You are encouraged to complete your assignments in groups, but each student must submit their own work in the end (collaboration on how to solve problems is allowed, but your submission must be your own writing). I will mark the assignments.

Midterm (20%)

There will be a midterm on February 29, the Thursday after the study break, on everything covered in the class before the study break. This will be a closed-book exam. The midterm will be during class time so you will have 80 minutes to complete the test. I will mark the midterms.

Final Exam (40%)

The final exam for this class will take place over the exam period in April and will be based on all the material we cover in the class. The exam will be closed-book and in person. This will be a three-hour exam. Please do not make any travel plans before the exam schedule is published by the school. I will mark the final exams.

Letter Grade Distribution:

Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale.

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (< 50)
A- (80-84)	B- (70-72)	C- (55-59)	

Course-specific policies

- No late assignments will be accepted. If you miss an assignment or midterm, a score of 0 will be assigned unless you fill out the Student Self-Declaration of Absence (SDA) form online in Brightspace. For a missed assignment, the 0 will be ignored and the weight from the assignment will be split equally between the remaining assignments. For a missed midterm, you must contact me at is374247@dal.ca on the date of the midterm and provide your availability so that a make-up midterm can be scheduled at a later date in my office. All students who miss a test must write the make-up test. No more than two (2) SDAs may be used by a student in the course.
- It is understood that sometimes people need more time to complete the assignments. If you occasionally need a short extension, you should email me at least three days before the assignment is due to set up a later time to hand in the assignment/take the midterm. However, if this request becomes too common, this privilege will be revoked. When a request is made ahead of time, you do not need to submit a Student Declaration of Absence.
- Submitting work written by someone else, by generative AI, or by any large language model is not allowed in this class. If I see any evidence of this, you will be contacted and a formal inquiry will be made with the university.

UNIVERSITY STATEMENTS

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: <https://www.dal.ca/about-dal/internationalization.html>

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (<https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html>)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: <http://www.dal.ca/cultureofrespect.html>

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at:

https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at:

https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.

UNIVERSITY POLICIES, GUIDELINES, AND RESOURCES FOR SUPPORT

University Policies and Programs

Important Dates in the Academic Year (including add/drop dates):

http://www.dal.ca/academics/important_dates.html

Classroom Recording Protocol: https://www.dal.ca/dept/university_secretariat/policies/academic/classroom-recording-protocol.html

Dalhousie Grading Practices Policies: https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Grade Appeal Process: https://www.dal.ca/campus_life/academic-support/grades-and-student-records/appealing-a-grade.html

Sexualized Violence Policy: https://www.dal.ca/dept/university_secretariat/policies/health-and-safety/sexualized-violence-policy.html

Scent-Free Program: <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>

Learning and Support Resources

General Academic Support – Advising (Halifax): https://www.dal.ca/campus_life/academic-support/advising.html

General Academic Support – Advising (Truro): <https://www.dal.ca/about-dal/agricultural-campus/ssc/academic-support/advising.html>

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness.html

On Track (helps you transition into university, and supports you through your first year at Dalhousie and beyond): https://www.dal.ca/campus_life/academic-support/On-track.html

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Indigenous Connection: <https://www.dal.ca/about-dal/indigenous-connection.html>

Elders-in-Residence (The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit the office in the Indigenous Student Centre or contact the program at

elders@dal.ca or 902-494-6803: <https://cdn.dal.ca/content/dam/dalhousie/pdf/academics/UG/indigenous-studies/Elder-Protocol-July2018.pdf>

Black Student Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre.html

South House Sexual and Gender Resource Centre: <https://southhousehalifax.ca/about/>

LGBTQ2SIA+ Collaborative: <https://www.dal.ca/dept/vpei/edia/education/community-specific-spaces/LGBTQ2SIA-collaborative.html>

Dalhousie Libraries: <http://libraries.dal.ca/>

Copyright Office: <https://libraries.dal.ca/services/copyright-office.html>

Dalhousie Student Advocacy Services: <https://www.dsu.ca/dsas?rq=student%20advocacy>

Dalhousie Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

Human Rights and Equity Services: <https://www.dal.ca/dept/hres.html>

Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Study Skills/Tutoring: http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Faculty of Science Advising Support: <https://www.dal.ca/faculty/science/current-students/undergrad-students/degree-planning.html>

Safety

Biosafety: <http://www.dal.ca/dept/safety/programs-services/biosafety.html>

Chemical Safety: <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

Radiation Safety: <http://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

Laser Safety: <https://www.dal.ca/dept/safety/programs-services/radiation-safety/laser-safety.html>