

Dalhousie University

Mathematics and Statistics CSCI/MATH 2113.03 : Discrete Structures II

Winter 2020

MWF, 12:35 – 13:25, LSC-COMMON AREA C236

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Course Description

This class continues the exploration of discrete mathematics started in Discrete Structures I. It aims to further develop logical reasoning skills which are important to computer science and mathematics. Elementary counting techniques lead to sophisticated methods to approach combinatorial problems. These methods include bijective counting and discrete probability. Structures such as partitions, permutations, symmetry groups, graphs and trees are introduced. Finally, discrete principles are applied to computation, transmission, and correction of digital information.

Course Prerequisites

CSCI/MATH 2112.03: Discrete Structures I.

Course Learning Outcomes

- Be able to count combinatorial objects using elementary techniques.
- Be able to read a description of a counting problem and derive a recurrence relation to solve the problem.
- Recognize common counting-related sequences such as Fibonacci numbers, Catalan numbers, and Stirling numbers.
- Be able to compose and manipulate generating functions, and use generating functions to obtain a direct formula for a recursively defined sequence.
- Understand discrete probability spaces and random variables. Be able to compute the expected value of a discrete random variable by expressing it as a sum of relevant indicator variables and using linearity of expectation.
- Be able to define and recognize partitions, permutations, groups, graphs and trees. Know the difference between labelled and unlabelled graphs and trees, and ordered and unordered trees.
- Be able to find the multiplicative subgroups of the integers modulo a given integer.
- Be able to define Shannon entropy and describe what it represents.
- Know the relationship between entropy and compressibility. Be able to find the optimally compressed representation of a random binary channel using Huffman codes.
- Know the basic concepts of error-correction in binary channels. Be able to encode and decode messages with a linear code. Be able to construct Hamming codes.
- Be able to distinguish between countable and uncountable sets. Know Cantor's diagonalization argument.

Learning Management System Site Information

Lecture notes and assignments will be posted on Brightspace (<https://dal.brightspace.com/>).

Suggested Texts

There is no required textbook for the course, but the following texts are good resources for supplementary reading.

- *Principles and Techniques in Combinatorics* (PTC), by Chen Chuang-Chong and Koh Khee-Meng.
- *Lectures in Discrete Mathematics* (DM), by Edward A. Bender and S. Gill Williamson.
- *The Book of Proof* (BoP), by Richard Hammack.
- *Abstract Algebra: Theory and Applications* (AA), by Thomas W. Judson.
- *Discrete Mathematics, and Open Introduction* (OI), by Oscar Levin.
- *A Student's Guide to Coding and Information Theory* (SG), by Stephan M. Moser and Po-Ning Chen.
- *Elementary Probability* (EP), by David A. Santos.

Some of the above texts are publicly available and links to these texts are on BrightSpace.

Course Schedule

The schedule below is subject to change.

Week	Dates	Topic	Reference
1	06/01 – 10/01	Relations: order & equivalence	DM: Unit EO, BoP: 11.1 – 1.4
2	13/01 – 17/01	Combinatorics II	
3	20/01 – 24/01	Relations, functions, and cardinalities I	
4	27/01 – 31/01	Relations, functions, and cardinalities II	
5	03/02 – 07/02	Recurrence relations	
6	10/02 – 14/02	Generating functions	
7	17/02 – 21/02	Winter study break	
8	24/02 – 28/02	Discrete probability I	
9	02/03 – 06/03	Discrete probability II	
10	09/03 – 13/03	Group theory	
11	16/03 – 20/03	Information theory I	
11	23/03 – 27/03	Information theory II	
12	30/03 – 03/04	Error correction	
13	06/04	Computability	

Important dates

- January 31st 2020: last day to drop without a W,
- February 7th 2020: Munro Day (university closed),
- March 9th 2020: last day to drop with a W, and
- April 8th to 24th 2020: exam period.

For further information, please consult: https://www.dal.ca/academics/important_dates.html

Course Assessments

The final grade for the course will be computed as the maximum of the grades obtained from the two schemes below.

	Scheme 1	Scheme 2
Assignments	20%	20%
Midterm 1	20%	0%
Midterm 2	20%	0%
Final	40%	80%

The conversion of numeric to letter grades follows the Dalhousie grading scale which can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Weekly assignments will be posted on Brightspace. There will be two midterms which will take place in class on Friday February 14th 2020 and on Friday March 13th 2020. The final examination will last three hours, will take place during the exam period, and will be scheduled by the registrar.

Course policies

- *Assignments*
 - Assignments must be submitted at the beginning of class on the due date.
 - Late assignments will not be accepted and will be given a grade 0 unless a prior arrangement was made.
 - Assignments must be legible. Marks will be deducted for poor readability.
 - Students are encouraged to work collaboratively on problems but their submissions should be prepared individually.
 - Additional problems will be assigned to graduate students.
- *Examinations*
 - Missed exams will be given a grade 0 unless a prior arrangement was made.
 - Textbooks, course notes, and calculators are not permitted during exams.
- *Recordings*
 - Students are not permitted to record the lectures.

Learning centres

Two learning centres are available to CSCI/MATH 2113 students where teaching assistants can provide help.

- The mathematics and statistics learning centre: <https://www.dal.ca/faculty/science/math-stats/about/learning-centre.html>
- The faculty of computer science learning centre: <https://www.dal.ca/faculty/computerscience/about/learningcentre.html>

Learning and Support Resources

- General Academic Support – Advising
Halifax: https://www.dal.ca/campus_life/academic-support/advising.html
Truro: <https://www.dal.ca/about-dal/agricultural-campus/student-success-centre/academic-support.html>
- Fair Dealing Guidelines
<https://libraries.dal.ca/services/copyright-office/guidelines/fair-dealing-guidelines.html>
- Black Students https://www.dal.ca/campus_life/communities/black-student-advising.html
- International Students https://www.dal.ca/campus_life/international-centre.html
- Indigenous Students https://www.dal.ca/campus_life/communities/indigenous.html
- The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Contact the elders at the Indigenous Student Centre (1321 Edward Street), by email at elders@dal.ca or by phone at 902-494-6803.
- Student Health Services http://www.dal.ca/campus_life/health-and-wellness/health-services.html
- Counselling https://www.dal.ca/campus_life/health-and-wellness/counselling.html
- Dalhousie Libraries <http://libraries.dal.ca>
- Copyright Office <https://libraries.dal.ca/services/copyright-office.html>
- E-Learning website <http://www.dal.ca/dept/elearning.html>
- Writing Centre https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html
- Faculty or Departmental Advising Support: Studying for Success Program http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html
- Student Finance page: https://www.dal.ca/admissions/money_matters.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
- Black Student Advising Centre https://www.dal.ca/campus_life/communities/black-student-advising.html
- International Centre http://www.dal.ca/campus_life/student_services/international-centre.html
- South House Sexual and Gender Resource Centre <https://southhousehalifax.ca/about/>
- LGBTQ2SIA+ Collaborative - <https://www.dal.ca/dept/hres/education-campaigns/LGBTQ2SIA-collaborative.html>
- Dalhousie Student Advocacy Services <http://dsu.ca/dsas>
- 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
- Academic Advising: <https://www.dal.ca/faculty/science/math-stats/programs/academic-advising.html>

University Policies, Statements, Guidelines

This course is governed by the academic rules and regulations set forth in the University Calendar and the Senate.
<https://academiccalendar.dal.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog>

University Statements

- *Territorial Acknowledgement*
Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people.

- *Academic Integrity*

At Dalhousie University, we are guided in all of 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 of 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. (read more: http://www.dal.ca/dept/university_secretariat/academic-integrity.html)

- *Accessibility*

The Student Accessibility Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students on the Halifax campus who request accommodation as a result of: a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (NS, NB, PEI, NFLD).

If there are aspects of the design, instruction, and/or experiences within this course 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.
- the Student Success Centre in Truro for courses offered by the Faculty of Agriculture (<https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.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. (read more: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/student-life-policies/code-of-student-conduct.html)

- *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. Dalhousie is strengthened in our diversity and dedicated to achieving equity. We are committed to being a respectful and inclusive community where everyone feels welcome and supported, which is why our university prioritizes fostering a culture of diversity and inclusiveness. (read more: <https://www.dal.ca/cultureofrespect.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. (read more: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html)

University Policies and Programs

- Important Dates in the Academic Year (including add/drop dates)
http://www.dal.ca/academics/important_dates.html
- Dalhousie Grading Practices Policy
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
<http://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>