

Topics in Graph Theory Syllabus

Department of Mathematics and Statistics

MATH 4330/CSCI 4115 Fall 2023

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.

Course Instructor(s)

Name	Email	Office Hours
Jason Brown	jason.brown@dal.ca	MW 11:30 – 13:00, Chase 216
Isaac McMullin	Is374247@dal.ca	

Course Description

This course covers current research topics in graph theory. Items are selected from the following topics: graph colourings, combinatorial optimization, random graphs, network analysis, graph clustering, processes on graphs.

Course Prerequisites

MATH 3330.03 or CSCI 3110.03 or permission of the instructor.

Course Exclusions

MATH 5330.03

Student Resources

Office hours with the instructor are available Mondays and Wednesdays, 11:30 – 13:00 in Chase 216.

Course Structure

Course Delivery

Course delivery is in-person.

Lectures

MW 10:05-11:25 in Chase 227.

Course Materials

Textbook: *Chromatic Polynomials and Chromaticity of Graphs* by F.M. Dong, K.M. Koh and K.L. Teo, World Scientific, New Jersey, 2005. (A pdf of the textbook is freely available from the Dalhousie University library.)

Course will have a Brightspace page.

Assessment

Assignments

Assignment #1 (due October 11, 2023), 7.5% of final grade

Assignment #2 (due October 25, 2023), 7.5% of final grade

Assignment #3 (due November 6, 2023), 7.5% of final grade

Assignment #4 (due November 29, 2023), 7.5% of final grade

Tests/quizzes

Midterm examination (November 20, 2023), 80 minutes (during class time), 40% of final grade. The midterm will cover calculation of chromatic polynomials, properties of chromatic polynomials (including their coefficients), chromatic uniqueness and equivalence, and chromatic roots.

Presentations

Students will work in groups and present (25 minutes) the contents of a research paper provided to them, and answer questions based on their presentation. This will occur during class time, December 4-6, 2023. This accounts for 25% of final grade.

Class Participation

Students will be assigned a grade for their overall participation in the including the answering and asking of questions. This accounts for 5% of final grade.

Conversion of numerical grades to final letter grades follows the

[Dalhousie Grade Scale](#)

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59)	

Course Policies on Missed or Late Academic Requirements

No late assignments will be accepted. If you miss an assignment or the midterm exam, a score of 0 will be assigned unless you fill out the Student Self-Declaration of Absence (SDA) form online in Brightspace (an SDA form can be used at most twice in the course). For a missed midterm, you must contact the instructor at jason.brown@dal.ca on the scheduled date of the midterm, along with your schedule so that a make-up midterm can be scheduled. All students who miss the midterm must write the make-up midterm. The SDA form cannot be used for missing the presentation.

Course Policies related to Academic Integrity

All assignments are to be completed independently; no group assignments are allowed. The presentations will be assigned to small groups. Generative AI and large language models (e.g., ChatGPT) are not to be used for any portion of the course.

Learning Objectives

This course presents a topic in graph theory (this year the topic is chromatic polynomials).

Objective: “The student will be able to recall salient definitions in graph theory.”

Condition: Given a simple statement involving terminology on graphs.

Behaviour: The student will be able to recall and use the definition in a short proof.

Objective: “The student will be able to understand and utilize basic principles in counting graph colourings.”

Condition: Given a statement involving counting graph colourings.

Behaviour: The student will be able to provide a proof.

Objective: “The student will be able to convert between various expansions of the chromatic polynomial”

Condition: Given either a graph.

Behaviour: The student will be able to produce the standard, factorial and tree forms of the chromatic polynomial and be able to convert between them.

Objective: “The student will be able to interpret the coefficients of the chromatic polynomial.”

Condition: Given a graph.

Behaviour: The students will be able to interpret the coefficients of the chromatic polynomial.

Objective: “The student will be able determine the chromatic equivalence class of a graph.”

Condition: Given a graph.

Behaviour: The student will be able to find all graphs with the same chromatic polynomial.

Objective: “The student will be able to understand various polynomials (adjoint, sigma) associated with the chromatic polynomial.”

Condition: Given a graph.

Behaviour: The student will be able to calculate the adjoint and sigma polynomials of the graph.

Objective: “The student will learn the theory of the roots of chromatic and related polynomials.”

Condition: Given a graph.

Behaviour: The student will be able to understand the theory of chromatic roots and the roots of the associated polynomials, and produce relevant proofs, using a background in algebra and analysis.

Course Content

- 1) Number of Colourings and Theirs Enumerations
 - a) Basic enumeration
 - b) Forms of the chromatic polynomial
 - c) Graph operations

- 2) Chromatic Polynomials
 - a) Interpretation of the coefficients
 - b) Broken-cycle theorem
 - c) Unimodal conjecture

- 3) Chromatic Equivalence
 - a) Definitions and basic results
 - b) Chromaticity of families of graphs

- 4) Related Graph Polynomials (Adjoint, Sigma)
 - a) Definitions
 - b) Basic results

- 5) Chromatic Roots
 - a) Definitions
 - b) Results (real roots, integral roots, complex roots)

University Policies and 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.