

## ACKNOWLEDGEMENT

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UBC's Point Grey Campus is located on the traditional, ancestral, and unceded territory of the  $x^w m\theta k^w \acute{y}\acute{e}m$  (Musqueam) people. The land it is situated on has always been a place of learning for the Musqueam people, who for millennia have passed on in their culture, history, and traditions from one generation to the next on this site.

## COURSE INFORMATION

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Course Title	Course Code Number	Credit Value
Graphs and Networks	MATH 442	3

## PREREQUISITES

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3rd year standing and one of MATH 220, MATH 223, MATH 226 or CPSC 221.

## COREQUISITES

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There are no corequisites.

## CONTACTS

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Course Instructor(s)	Contact Details	Office Location	Office Hours
Farid Aliniaiefard	Email: farid@math.ubc.ca	MATH 209; during the first two weeks, we do not have any in-person office hours. All office hours are online using Zoom. After two weeks, the location for office hours is MATX 1101.	Tuesday 1:00-2:00 pm Pacific Time, Thursday 12:00-1:00 pm Pacific Time, and by appointment. You can also email me anytime.

## OTHER INSTRUCTIONAL STAFF

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There will be one graduate student who will grade student homework.

## COURSE STRUCTURE

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This is an introduction to graph theory. There will be an emphasis on proof techniques. Topics include tours and graphs, planarity, graph colouring, trees, shortest paths, and algorithms. Since this is a Mathematics Majors course, there is a median grade of around 68% and students are expected to perform calculations and construct rigorous proofs involving fundamental ideas of the course.

This course is lecture-based using Zoom during the first two weeks. After two weeks, we conduct in-person lectures. This course is integrated with during the lecture activities such as small group work, question and answer sessions, and student board/Zoom whiteboard work. There will be two midterm exams during the lecture time and one final exam. There will be a weekly homework assignment due on Tuesdays at the start of class, 2:00 pm Pacific Time (except the first assignment), and posted on the course Canvas website approximately two weeks in advance.

Time: Tuesday and Thursday 2:00-3:20 pm Pacific Time.

Location: First two weeks, we use Zoom, after two weeks Mathematics Annex, Room 1100.

First Midterm date: Thursday, February 3, 2022.

Second Midterm date: Thursday, March 10, 2022.

Web page: [Graphs and Networks \(Click\)](#)

This course will be online for a portion of the term. We will start in-person meetings on a date yet to be determined by the University. At the very earliest, this will be on January 24. This date may be updated as time goes on. When we resume in-person activities, we will meet in our scheduled classroom space Mathematics Annex, Room 1100. For meetings prior to that time, we will meet on Zoom. For details, on the Canvas web page of the course, click on Zoom in the left-hand side menu. The midterm dates may be changed if the University defers starting in-person classes on January 24.

## SCHEDULE OF TOPICS

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### Week 1

Common proof techniques: Constructive, contrapositive, contradiction, induction.

Examples

### Week 2

Ch1: Definitions, isomorphism, subgraphs

Ch1: Adjacency

Ch1: Flavours of graphs, bipartite graphs

Week 3

Ch2: Eulerian graphs

Ch2: Fleury's algorithm, Hamiltonian graphs

Ch2: Ore's theorem, Dirac's theorem

Week 4

Midterm 1

Ch1: Instant Insanity

Ch4: Planarity, Euler

Week 5

Ch4:  $K_5$ ,  $K_{3,3}$

Ch4: Kuratowski's theorem

Ch4: Glasgow algorithm

Week 6

Ch5: Polyhedra

Ch5: Colouring

Week 7

Ch5: Brooks' theorem

Ch5: Chromatic polynomial

Week 8

Midterm 2

Ch5: 5-colouring

Week 9

Ch5: Face colouring

Ch5: Edge colouring

Ch5: Timetabling

Week 10

Ch3: Trees

Ch3: Prufer sequences, Cayley's theorem

Ch3: BFS/DFS

Week 11

Ch2: Shortest path/mazes

Ch2: Minimum spanning trees

Ch2: TSP

Week 12

Ch2: Digraphs

Ch2: Acyclic orientations

Ch6: Network flows

Week 13

Ch2: Critical path analysis

Ch2: Longest path

If changes occur, then students will be informed.

## LEARNING OUTCOMES

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The overarching goal of this course is to provide students with an introduction to graph theory and its applications through proof and algorithmically. Specific objectives include:

1. Understanding graphs and networks, and related algorithms that can be used to solve physical problems.
2. The application of graphs and networks to numerous settings, including colouring and maximisation/minimisation.
3. Investigating trees and tree growing algorithms.
4. Studying many graphs and network theoretic phenomena and the variety of proof techniques required to explain them.

By the end of the course, students will be able to:

- Recall and identify types of graphs and networks and the criteria that they satisfy. Apply appropriate algorithms to solve studied real-world problems and adapt them to related problems. This corresponds to course objective (1) above.
- Demonstrate integrative knowledge by applying tools from this course to a wide variety of problems both inside and outside the course content. This corresponds to course objective (2).
- Appraise when a problem may be solved using trees. Differentiate between the different algorithms using trees, both in their use and their output. This corresponds to course objective (3).
- Assemble graph-theoretic data to conjecture formulae and justify these and known formulae through rigorous proof. Appraise which proof technique is most appropriate to apply. This corresponds to course objective (4).

## LEARNING ACTIVITIES

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There will be during the lecture activities such as small group work, question and answer sessions, and student board/Zoom whiteboard work.

## LEARNING MATERIALS

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Textbook: Robin J Wilson, Introduction to Graph Theory (4th Edition).

This textbook is optional and contains sketches of some of the proofs plus additional practice exercises. There will also be a copy available to view during office hours and multiple copies in the library so purchasing the book is not necessary.

## ASSESSMENTS OF LEARNING

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Your grade will be based on the following,

- Attendance and during the lecture activities (5%)
- Homework (20%): Due by 2:00 pm Pacific Time each Tuesday (except the first homework).
- Midterm 1 (20%): 2:00-3:20 pm Pacific Time on February 3, 2022.
- Midterm 2 (20%): 2:00-3:20 pm Pacific Time on March 10, 2022.
- Final exam (35%): TBA.

## UNIVERSITY POLICIES

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UBC provides resources to support student learning and to maintain healthy lifestyles but recognises that sometimes crises arise and so there are additional resources to access, including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available on the <https://senate.ubc.ca/policies-resources-support-student-success> UBC Senate website.

## OTHER COURSE POLICIES

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**Academic misconduct:** Regardless of whether you arrive at homework solutions in collaboration with others or alone, the paper that you turn in with your name on it should represent your solutions, written in your own words. In particular, you may not simply copy someone else's homework and turn it in as your own. Similarly, copying solutions that you might find on the web or from some other source is illegal.

These will all be treated as academic misconduct. We take all academic misconduct very seriously and will follow university procedures in all cases - disciplinary measures can result in expulsion.

There is anecdotal evidence that quite a bit of cheating occurs on campus. To prevent one common form of cheating, we will scan assignments and exams before returning them.

**Homework and exams:** We will not accept late homework, we will, however, drop the lowest homework grade.

Calculators, books, notes etc are not permitted in either exam, however, bring your student ID to all exams. There are no make-up or alternate exams, so make sure you do not make personal travel plans or work plans etc that will conflict.

Any student who misses a midterm exam is to present to their instructor the Department of Mathematics self-declaration form for reporting a missed assessment within 72 hours of the midterm exam date. This policy conforms with the UBC Vancouver Senate's Academic Concession Policy V-135 and students are advised to read this policy carefully. If a concession is made then the midterm exam is weighted to the final exam.

**Class etiquette:** Use of cell phones (in any manner), laptops, smartphones, tablets, and other electronic devices during in-person classes is highly inappropriate, as it is distracting and disrespectful to fellow students and the instructor. Chatting with neighbours, even when whispered, is equally inappropriate.

Arriving late and leaving early is also discouraged. If it happens, please enter/leave the room/Zoom meeting silently and do not disrupt the other students or instructor.

## LEARNING ANALYTICS

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In this course, data from grades will be used to:

- View overall class progress
- Track individual progress to provide personalised feedback.

## COPYRIGHT

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All materials of this course are the intellectual property of the Course Instructor or licensed to be used in this course by the copyright owner. Redistribution of these materials by any means

without the permission of the copyright holder(s) constitutes a breach of copyright and may lead to academic discipline.

Students are not permitted to record classes.

*Version: December 16, 2020*