Acknowledgement

UBC's Point Grey Campus is located on the traditional, ancestral, and unceded territory of the xʷməθkʷəy̓əm (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

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

Prerequisites

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

Corequisites

There are no corequisites.

Contacts

Course Instructor(s)	Contact Details	Office Location	Office Hours
Farid Aliniaeifard	Email: farid@math.ubc.ca	LSK 121, during the pandemic, we do not have any in-person office hours. All office hours and lectures are online using Zoom.	Tuesday 1:00-2:00 pm Pacific Time, Thursday 3:30-4:30 pm Pacific Time,Tuesday 5:00-6:00 pm Pacific Time, and by appointment. You can also email me anytime.

Other Instructional Staff

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

Course Structure

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 online lecture based using Zoom, integrated with during the lesson activities such as small group work, question and answer sessions, and student 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 1:59 pm Pacific Time (except the first assignment), and posted on the course website approximately 2 weeks in advance.

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

First Midterm date: Thursday, February 4, 2021.

Second Midterm date: Thursday, March 11, 2021.

Web page: https://faridanf.github.io/Math442/

Schedule of Topics

Week 1

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

Week 2

Ch1: Definitions, isomorphic, 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

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 maximization/minimization.
3. Investigating trees and tree growing algorithms.
4. Studying many graph 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 in order 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 in order 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

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

Learning Materials

Textbook: Robin J Wilson, Introduction to Graph Theory (5th Edition), Pearson ISBN-13: 978-0-273-72889-4, approximately $60 new.

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

Your grade will be based on the following,

- Attendance and during the lecture activities (5%)
- Homework (20%): Due by 1:59 pm Pacific Time each Tuesday (except the first homework).
- Midterm 1 (20%): 2:00-3:20 pm Pacific Time on February 4, 2021.
- Midterm 2 (20%): 2:00-3:20 pm Pacific Time on March 11, 2021.
- Final exam (35%): TBA.

University Policies

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes 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 for 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

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 own 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. In an effort 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.

You also should bring your student ID to all exams in this course.

There are no make-up or alternate exams.

Any student who misses the 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: If you have a question then please ask the instructor so the whole class may benefit too.

Entering late and leaving early is also discouraged and it will effects your grade. If it happens then please enter/leave the Zoom meeting silently and do not disrupt the other students or instructor.

Learning Analytics

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

- View overall class progress
- Track individual progress in order to provide personalized feedback.

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