Faculty of Science Course Syllabus (Section A)
Department of Mathematics and Statistics, Dalhousie University
Winter 2025

MATH 2051 - Problems in Geometry

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

1 Instructor & Course Component Details

Instructor Dr. Dorette Pronk, Office: Chase 302, email: pronkd@dal.ca

Lectures MWF 10:35 - 11:25 AM in Chase 319

Lectures are in person and attendance is mandatory. However, if you are not able to attend due to illness or another valid reason, please contact me and I will run a livestream on the following Zoom link:

`https://us02web.zoom.us/j/87114978886?pwd=dmJ0R3F4cUhkWjFFWC85YmZrMThxUT09`

(or meeting ID: 871 1497 8886 with Password: construct)

Office Hours M 11:30 AM - 12:30 PM, T 4 - 5 PM, F 11:30 AM - 12:30 PM, or by appointment.

Office hours at the scheduled times are normally in person in my office, but all office hour appointments can also be scheduled on Zoom. If you come to my office, please refrain from wearing any scented products. If you do wear them, I will ask you to meet with me on Zoom, as most scented products cause me to get a migraine. The link for office hours is:

`https://us02web.zoom.us/j/81897694898?pwd=UFlWQ2JWbG5TQXladzU4dE10YVFKUT09`

(or meeting ID: 818 9769 4898 with Password: solutions)

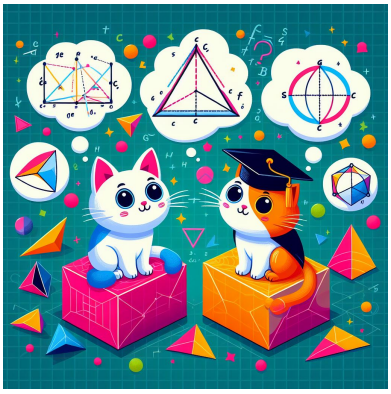
2 General Information

Course Description: This is a basic course for all students interested in geometry. Topics from Euclidean and non-Euclidean geometry may include: transformation geometry, symmetry groups, frieze groups, wallpaper groups and the crystallographic restrictions, similarities; projective geometry and the classical theorems of Menelaus, Ceva, Desargues, Pappus, Pascal; hyperbolic geometry.

Prerequisites: MATH 1010 or permission from the instructor.

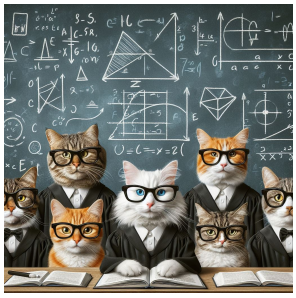
Corequisites: MATH 1030 or MATH 2030

2.1 Learning Objectives

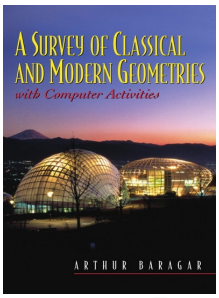


- Enjoy the beauty of geometry and learn more about its intricacies; ask lots of questions!
- Experience with the axiomatic approach to geometry and be able to write and recognize a proper proof for basic geometric results: I will present proofs in class, and you will be required to provide proofs for results in your assignments.
- Familiarity with the basic results in Euclidean geometry.
- Familiarity with the properties of lines and circles in Euclidean geometry.
- Familiarity with the properties of Euclidean isometries and inversion in a circle.
- Know the results and arguments from neutral geometry.
- Be familiar with the Klein and Poincaré models for hyperbolic geometry and the ways they are related.
- Be able to perform straight-edge and compass constructions in both Euclidean and hyperbolic geometry and prove certain selected constructability results.
- Be able to do independent literature research in mathematics and report about this in a poster presentation and a short written project.

Class Structure: Generally a lecture will start with a discussion of the warm-up problem I have given to prepare for the lecture. Then I will teach on the topic of the day and will generally keep the class very interactive - I may ask you to solve certain problems in small groups and report on what you find. The course will consist of a combination of exploration and learning to give precise proofs for your results.



Course Materials: Our main textbook is freely available online. (It is out of print, but you may be able to find a second-hand copy if you want a hard copy of the book.) We will also extensively use Cinderella, a program that implements the geometry construction rules. This program is also freely available. It is important that you download it as soon as possible and do the exercises I assign to familiarize yourself, because this will be an integral part of the course.



- Arthur Baragar, *A Survey of Classical and Modern Geometries with Computer Activities*, Second Edition, John Wiley and Sons, 2006. (This book is available under the open math notes of the AMS, and also as a file on our Brightspace course website.)
- Cinderella, a geometry software package, freely downloadable at `https://beta.cinderella.de/`; for instructions and examples, see `https://cinderella.de/tiki-index.php` and `https://cinderella.de/files/HTMLDemos/`.

3 Course Assessment

Homework: This class has two types of regularly scheduled homework:

- A short "in-class problem" that is assigned to prepare for each class. Doing these helps you prepare to actively participate each class. It is important to not only do these but also discuss the ideas involved with others in the course. You can do this in class, or on the Brightspace discussion board. Your activity will be reflected in the class-participation grade.
- The weekly home-work that is due each Wednesday in the Brightspace dropbox. Please submit your written work in one pdf file, together with the Cinderella work in separate files for each construction. (For the Cinderella work, include the images of the constructions as part of your written work and hand in the actual constructions as .cdy files - you need both to get full marks.)

Group Projects: As part of this course you are required to participate in a group project.

- Groups should consist of 3-5 students.
- Projects will be posted on Brightspace and will cover topics from the history of geometry, applications of geometry to other parts of mathematics, geometry and art, constructions, and different types of geometry. If you have an idea for a topic that is not listed, ask the instructor about this during the month of January and if suitable she will create a project outline for the new topic. Also, if you would like to take an existing project in a new direction, discuss this with the instructor.
- You need to form your groups and choose your topic by the end of the second week of February and give this information to the instructor (each topic can be chosen by at most one group). Groups and topics will be listed on Brightspace.
- During the week after the midterm each group needs to meet with the instructor to discuss their plans.
- Each group is required to make a poster about their results and to write a short paper.
- The posters for the projects will be presented in class on Friday, April 4 (generally, SDAs are not allowed for this component except in extreme circumstances because you should be working on this as a group for a whole month before this is due). The April 4 class will be run like a poster session at a conference; make sure you arrive on time to set up your poster.
- The paper part of the project is due on April 7, the last day of classes.

Midterm Test The midterm test is on **Wednesday, February 26, from 7 till 9 PM** in Dunn 304.

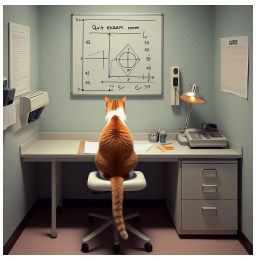
Final Exam The final exam is 3 hours long. The date and time for the final exam is set by the registrar during the official Dalhousie exam period from April 9 till April 26. If you plan to depart from campus at the end of the semester, please make your plans after the registrar has announced the exam schedule, or plan to leave after April 23. Unfortunately, there are no opportunities to write the exam early or remotely.

Course score: I will use the maximum of the following two columns for you:

Weekly Assignments	25%	Weekly Assignments	25%
Participation (discussion boards, class, office hours)	5%	Participation	5%
Group Project Poster	10%	Group Project Poster	10%
Written Group Project (submit one per group)	10%	Written Group Project	10%
Midterm Test	15%		
Final Exam	25%	Final Exam	40%

The grading scheme for this course will follow the standard scale set by Dalhousie University.
`https://www.dal.ca/campus_life/academic-support/grades-and-student-records/grade-scale-and-definitions.html`

4 Student Accommodations



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 `dal.ca/access`. Also, I welcome suggestions for changes in the way I deliver this course.

5 Welcome to new discoveries!

Geometry is the archetype of the beauty of the world.
–Johannes Kepler

Course topics and approximate schedule

week 1 Properties of Lines and Circles, in the plane and on other objects.

week 2 Axioms for Euclidean geometry, in terms of isometries.

week 3 Basic results from neutral and Euclidean geometry: triangle congruence and similar triangles.

week 4 Basic results from neutral and Euclidean geometry on circles: Star Trek Lemma, Power of a Point, Radical Axes.`

week 5 Basic results from neutral and Euclidean geometry: centres of triangles and the Euler line.

week 6 Staight-edge and compass constructions - in theory and in Cinderella.

week 7 Constructible lengths, angles, and figures.

week 8 Inversion in a circle.

week 9 The parallel axioms and neutral geometry.

week 10 Hyperbolic geometry

week 11 Models for hyperbolic geometry

week 12 Constructions and calculations in hyperbolic geometry

week 13 Tilings and symmetry in Euclidean and hyperbolic geometry

6 Course Policies related to Academic Integrity

Submitting your written homework You are strongly encouraged to collaborate with other students when working on homework and discussing what you have learned in class. However, when you write up your solutions,you need to do so by yourself - I am not expecting to see the exact same solution more than once.

The group projects For group projects you are allowed and encouraged to use online and physical resources such as encyclopedia articles, scientific articles and textbooks, as indicated in the project descriptions. You need to cite the material you use appropriately. You are strongly discouraged from using ChatGPT or other AI software to create text for your poster or project paper. I will be asking questions about your work and if I notice that you are not able to explain what you have written and if it becomes clear that these are not your own words, I will not give you credit for the parts that were not written by you.

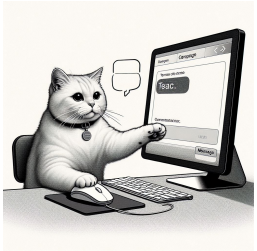
7 Course Policies on missed or late academic requirements

- In the event that you are absent for three days or fewer resulting in missed or late academic requirements, you will be required to submit a Student Declaration of Absence Form to your instructor, see:

  `https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/academic-policies/student-absence.html`

- I understand that circumstances can arise that can interfere with completing your work. I will drop your two lowest homework scores to function as a buffer for all.
- If you need to hand in your homework late, contact the instructor to alert the grader. If you do not do this, your work may not be marked at all. Unless you have a valid reason, the penalty for late homework is a 2 point deduction per day that it is late.

Midterm and Final exams: In the event that you are unable to attend the midterm or final exam, please notify the instructor via email in advance to determine what alternatives may be possible.



Note: all cat images in this syllabus were created with the chatgpt image generator.