

**Faculty of Science Course Syllabus**  
**Department of *MATHEMATICS***

*MATH2051*  
*Problems in Geometry*  
*Winter 2018*

**Instructor:** Dorette Pronk      [pronk@mathstat.dal.ca](mailto:pronk@mathstat.dal.ca)      Office: Chase 302

**Lectures:** TR 10:05-11:25 LSC C202

**Office Hours:** M 2:30 – 3:30, W 1:30 – 2:30, R 1:30 – 2:30

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### **Course Description**

This is a basic course for all students interested in geometry and the foundations of mathematics. Topics from Euclidean and non-Euclidean geometry may include: history of geometry, axioms for geometry and proofs based on axioms, finite and infinite models, 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 with various models.

### **Course Prerequisites**

MATH 1010 or MATH 1500X/Y (first year calculus) or permission from the instructor

### **Course Objectives/Learning Outcomes**

1. Learn to appreciate and work with an axiomatic approach toward mathematics in general and geometry in particular; write proper mathematical proofs.
2. Learn what Euclid's original axioms can and cannot do.
3. Recognize why the various parts of the axiom system are needed and how to use them in formal proofs.
4. Become familiar with the notion of models for axiom systems – be able to construct them and recognize which properties a given model has.
5. Learn about the history of the parallel postulate and become familiar with alternative versions.
6. Be able to reason without the use of the parallel postulate and recognize the role of the results one can prove this way.
7. Be able to prove results using the hyperbolic parallel postulate.
8. Become familiar with a couple of models for hyperbolic geometry, in particular the Poincaré disk and the Klein disk and the relations between these two models.
9. Learn to describe and study symmetry in both Euclidean and hyperbolic geometry: determine which symmetry is possible and how it can best be classified.

10. Learn the rules for straight edge and compass constructions and how they are related to the axioms and then implement them to work with a geometry software package.
11. Learn to do independent research in mathematics and present the results using a poster or presentation in class.

### Course Materials

- *Marvin Jay Greenberg, Euclidean and Non-Euclidean Geometries, Development and History, Fourth Edition, W.H. Freeman and Company, New York, 2008*
- *Cinderella (a free version that contains everything needed for this course is available on-line) [www.cinderella.de](http://www.cinderella.de)*
- *Geogebra Classic 6 (a free version that contains everything needed for this course is available on-line) <https://www.geogebra.org/download>*
- *Assignments and projects made available on Brightspace*

### Course Assessment

Component	Weight (% of final grade)	Date
<b>Tests/quizzes</b>		
<i>Midterm</i>	20%	<i>Thursday February 28</i>
<b>Final exam</b>	40%	<i>(Scheduled by Registrar)</i>
<b>Assignments</b>		
<i>Weekly</i>	20%	
<i>Group Poster</i>	10%	<i>Thursday March 21</i>
<i>Written Project</i>	10%	<i>Tuesday, April 2</i>

### Other course requirements

The group posters need to be presented in class on the dates indicated above, based on a project that you have worked on as a group. These projects can be done with groups of up to five students. Lists of project descriptions will be posted on the Brightspace website for this course. Projects can be focussing on particular geometric results, the history of geometry, or applications of geometry to arts and science. If a student is interested in a particular geometry related topic that has not been listed, they should contact the instructor and it may be possible to create a new project.

### Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

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

**Course Policies**

- There will be weekly assignments, which will be due on Thursdays in class and will be accepted until 5 PM in my office (302) without a penalty. If you hand them in later, there will be a penalty.
- You are allowed to discuss your work with your class mates when solving the assignment problems, but you are required to do your final write-up by yourself.
- This course will only be cancelled in relation to weather related emergencies when the university is officially closed. If homework was due on that date it will be due on the date of the next scheduled class for this course.
- Students need to be aware that the final exam for this course will be scheduled by the registrar's office and will be posted on February 1. The exam period for this year is April 9-23. Please do not book any airline tickets to go home for the summer until you have learned what the exam date is. I am not able to let students write the exam early, so you need to make sure that you are here for the official date.
- My office hours are Monday 1 – 2 PM; Wednesday 4 – 5 PM; Thursday 11:30 AM – 12:30 PM

**Course Content**

week 1 (January 8 and 10) A brief review of the ancient history of geometry, and elementary logic

week 2 (January 15 and 17) Incidence axioms and Models for Axioms

week 3 (January 22 and 24) Between-ness Axioms

week 4 (January 29 and 31) Congruence Axioms

week 5 (February 5 and 7) Axioms of Continuity and Constructions

week 6 (February 12 and 14) Constructions and Constructible Numbers

week 7 (February 19 and 21) Study Break (no classes)

week 8 (February 26 and 28) Review for Midterm and Midterm

week 9 (March 5 and 7) Neutral geometry

week 10 (March 12 and 14) Hyperbolic Geometry Axiomatically

week 11 (March 19 and 21) Models for Hyperbolic Geometry and Poster Presentations

week 12 (March 26 and 28) Inversion and Models for Hyperbolic Geometry

week 13 (April 2 and 4) Symmetry and Review for Exam

## University Policies and Statements

**This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate**

### 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 (The Center for Academic Integrity, Duke University, 1999). 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.

**Information:** [https://www.dal.ca/dept/university\\_secretariat/academic-integrity.html](https://www.dal.ca/dept/university_secretariat/academic-integrity.html)

### Accessibility

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

**Information:** [https://www.dal.ca/campus\\_life/academic-support/accessibility.html](https://www.dal.ca/campus_life/academic-support/accessibility.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.

**Code:** [https://www.dal.ca/dept/university\\_secretariat/policies/student-life/code-of-student-conduct.html](https://www.dal.ca/dept/university_secretariat/policies/student-life/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. 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

**Statement:** <http://www.dal.ca/cultureofrespect.html>

### 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 (1321 Edward St) ([elders@dal.ca](mailto:elders@dal.ca)).

**Information:** [https://www.dal.ca/campus\\_life/communities/indigenous.html](https://www.dal.ca/campus_life/communities/indigenous.html)

**Important Dates** in the Academic Year (including add/drop dates)

[https://www.dal.ca/academics/important\\_dates.html](https://www.dal.ca/academics/important_dates.html)

### University Grading Practices

[https://www.dal.ca/dept/university\\_secretariat/policies/academic/grading-practices-policy.html](https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html)

**Missed or Late Academic Requirements due to Student Absence (policy)**

[https://www.dal.ca/dept/university\\_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html](https://www.dal.ca/dept/university_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html)

## Student Resources and Support

### Advising

**General Advising** [https://www.dal.ca/campus\\_life/academic-support/advising.html](https://www.dal.ca/campus_life/academic-support/advising.html)

**Science Program Advisors:** <https://www.dal.ca/faculty/science/current-students/academic-advising.html>

**Indigenous Student Centre:** [https://www.dal.ca/campus\\_life/communities/indigenous.html](https://www.dal.ca/campus_life/communities/indigenous.html)

**Black Students Advising Centre:** [https://www.dal.ca/campus\\_life/communities/black-student-advising.html](https://www.dal.ca/campus_life/communities/black-student-advising.html)

**International Centre:** [https://www.dal.ca/campus\\_life/international-centre/current-students.html](https://www.dal.ca/campus_life/international-centre/current-students.html)

### Academic supports

**Library:** <https://libraries.dal.ca/>

**Writing Centre:** [https://www.dal.ca/campus\\_life/academic-support/writing-and-study-skills.html](https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html)

**Studying for Success:** [https://www.dal.ca/campus\\_life/academic-support/study-skills-and-tutoring.html](https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html)

**Copyright Office:** <https://libraries.dal.ca/services/copyright-office.html>

**Fair Dealing Guidelines** <https://libraries.dal.ca/services/copyright-office/fair-dealing.html>

### Other supports and services

**Student Health & Wellness Centre:** [https://www.dal.ca/campus\\_life/health-and-wellness/services-support/student-health-and-wellness.html](https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html)

**Student Advocacy:** <https://dsu.ca/dsas>

**Ombudsperson:** [https://www.dal.ca/campus\\_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html](https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html)

### Safety

**Biosafety:** <https://www.dal.ca/dept/safety/programs-services/biosafety.html>

**Chemical Safety:** <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

**Radiation Safety:** <https://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

**Scent-Free Program:** <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>