MATH 434: GEOMETRY AND TRANSFORMATIONS
FALL 2020 SYLLABUS

Disclaimer: This syllabus does not constitute a contract. The instructor reserves the right to make changes at his discretion throughout the semester.

General information:

- **Instructor:** Dr. Guillaume Dreyer
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- **Teaching Assistant:** TBA
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- **Textbook:** Francis Bonahon, *Low-Dimensional Geometry, From Euclidean Surfaces to Hyperbolic Knots*, ISBN: 9780821848166.
- **Prerequisites: MATH 226 or 227.** This is a proof-based course. While there are no other prerequisites, it is highly recommended you have taken a proof-based class such as Topology (440), Abstract Algebra (410a), Linear Algebra (471), Real Analysis (425a). If this is not the case, you should at least feel fairly comfortable with proofs. Also, basic knowledge of complex numbers and set-theoretic notations is expected (see Tool Kit Appendix in the textbook).
- **Lectures:** 2:00–2:50 pm MWF (ONLINE). **Attendance is mandatory.**

Grading breakdown: Homework 25%; 2 Midterm exams, 20% each; Final exam 35%.

Course topics and learning objectives: This course is an introduction to hyperbolic geometry and its applications to low-dimensional topology. While fundamental upper courses such as topology, real analysis, abstract and linear algebra feel fairly "disconnected", this course is more advanced as it brings all that foundational knowledge all together. We indeed will use concepts usually developed in all those classes to construct more "math", a feature that makes this course quite unique. It will be a journey that will take us a bit everywhere. Ultimately, this course will be a great opportunity to review and consolidate all the mathematical knowledge and skills you have learned so far while expanding your mathematical horizons.

We will closely follow the textbook for the most part. There will be digressions though.

- A review of Euclidean geometry (Chapter 1): the Euclidean plane $\mathbb{R}^2$, Euclidean length and distance, characterization of geodesics of $\mathbb{R}^2$, a bit of metric spaces, methods of vector and analytical geometry (including complex numbers), isometries of $\mathbb{R}^2$.
- A decent amount of hyperbolic geometry (Chapter 2): the hyperbolic plane $\mathbb{H}^2$ (upper-half plane model), hyperbolic length and distance, characterization of geodesics of $\mathbb{H}^2$, isometries of $\mathbb{H}^2$ and their properties.

- A bit of spherical geometry (Chapter 3): the 2–dimensional sphere $\mathbb{S}^2$ (spherical plane) , spherical length and distance, geodesics and isometries of $\mathbb{S}^2$.
- Surfaces obtained via gluing constructions (Chapters 4 and 5): Partitions and equivalence classes, gluing constructions and quotient spaces, metric and quotient metric (this is a special case of topology and quotient topology), surfaces as quotient spaces of a polygon whose edges are glued by isometries, examples.
- Tesselations, group actions and fundamental domains (Chapters 6 and 7): Tesselations, tiling groups, tesselation theorem, completeness and compactness, Poincaré's polygon theorem, group actions, fundamental domains, Dirichlet domains.
- Additional topics: To be determined later in the semester.

In addition to the above topics, lectures may include as needed short reviews of key concepts and methods (set theory, complex numbers, geometry, etc).

Homework: Weekly homework will be posted on BB every Wednesday. **Assignment are due the following Wednesday in class at the beginning of our lecture**. Late and electronically submitted homework will not be accepted, no exceptions. You are allowed to drop one HW score.

You are strongly encouraged to discuss homework problems with your peers and to work in groups. This is the most efficient and rewarding way to learn and work. However, you must write your own solutions. **Homework which is simply copied from another source (friend, another textbook, internet, etc.) will be considered as plagiarism, a serious offense to USC Student Code of Conduct.**

Exams: There will be two midterms and a final.

- **Midterm 1:** Friday, September 25th, in class.
- **Midterm 2:** Friday, October 30th, in class.
- **Final:** Friday, November 20th, 2:00–4:00 pm.

If there is a scheduling conflict for an exam, **you must let me know at least 2 weeks ahead**. A scheduling conflict must involve an activity sponsored and approved by USC (marching band, athlete event, etc.). In particular, the university club or organization in question must send an official request, with the Dean's approval, to all faculty. Personal activities do not qualify. **Failure to attend an examination will not be excused under no circumstances.**

Resources: The Math Center is located in KAP 263 and is open weekdays from 8 am to 7 pm (it closes earlier at 5 pm on Fridays). For up-to-date information on the consulting hours, visit the Math Center homepage `http://dornsife.usc.edu/mathcenter`. The purpose of the Math Center is to provide an environment where students can stop by to get help on their math classes. Math TAs at USC hold their office hours there. It is probably better to attend office hours of TAs who are teaching Math 126 this term. However, you are welcome to stop by the Math Center at any time and seek for help from any of the Instructors or TAs who are present at that time.

Students with disabilities: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester and a letter of verification detailing approved accommodations must be delivered to your Instructor as early in the semester as possible. DSP is located in STU 301 and is open 8:30–5:00 pm, Monday through Friday. The phone number for the DSP office is (213) 740–0776.