Name: Charles Daly **Math 1820A Spring 2024**

When & Where: MWF 1:00 PM (EST) - 1:50 PM (EST) **Sayles Hall 305**

Canvas Site: https://canvas.brown.edu/courses/1094919

Email: charles_daly@brown.edu

Office Hours: Monday 2:00 PM - 3:00 PM at 309 Kassar House (also online)

Friday 3:00 PM - 3:00 PM at 309 Kassar House (also online)

Office Hours: Tuesday 3:00 PM - 4:00 PM at Macmillan 115

Saturday 1:00 PM - 2:00 PM at Barus & Holley 155

Course Description: This course is meant to provide a bird's eye view of some topics in Lie theory with applications to geometry. The first half of the course will be dedicated to fundamentals such as the matrix groups, the exponential map, and Lie-algebras. The next part of the course will focus more on basic representation theory, accidental isomorphisms, and hyperbolic/affine geometry. While the book assigned in Hall's *Lie Groups, Lie Algebras, and Representations*, this will largely only be relevant for the first half the course (and available for free download on Springer via your Brown login). The second half of the course will largely be drawing from my own notes, which I will not be posting; however this material is well documented and you can find several different interpretations online. That said, some books that come to mind that are relevant are Katok's *Fuchsian Groups*, Fulton and Harris' *Representation Theory: a First Course*, Lee's *Riemannian Manifolds*, and Wolf's *Spaces of Constant Curvature*. You are *not* expected to obtain these materials and read them thoroughly; they just happen to have certain bits and pieces relevant to the course material.

Grading: Your grade will be determined by homework, and two exams: the midterm and final. The homework, midterm, and final are worth 35%, 30%, and 35% of your grade respectively. I will honor the following grade thresholds. Any total grade that is at least 90% is guaranteed an A or S with distinction. Any total grade that is at least 80% is guaranteed a B. Any total grade that is at least 70% is guaranteed a C or S. It is possible these thresholds will be moved down, but they will *not* be moved up.

Homework: There will be about ten homework assignments that will be assigned every week and a half or so, and will consist of problems assigned from the text. Specific problems will be posted on our Canvas site. Late assignments are allowed, up to five days from the due date, but will be deducted points depending on how late the assignment is submitted. You are allowed to form study groups and discuss the homework together, in fact I encourage this, but only after you attempt the homework yourself. You should engage with the problems on your own before discussing them with others. Homework will be graded *anonymously* through Gradescope, so please do *not* include your name on your submission.

Exams: The midterm is yet to be determined, but will ideally take place around Week 8, Mar 11th - Mar 15th. We will likely hold the midterm in the evening, in-class, to allow a generous amount of time. The exam itself will not be lengthier. The extended time period will be provided to remove the stress surrounding the time constraint. The final will be an in-class three hour cumulative exam on **May 9th at 9:00 AM (EST)**. If you need to miss either the midterm or final due to a university recognized excuse, with documentation, we will figure out a suitable make-up assignment.

Textbook: The textbook is Hall's *Lie Groups, Lie Algebras, and Representations* which is available through Springer via your Brown login. You are encouraged to check out other texts if you like.

Recordings and Covid-19 Policies: Given the Covid-19 pandemic, I am going to try and ensure all lectures are recorded. I have been told our classroom is equipped with a camera and speaker to adequately record lectures. This is done to ensure people who need to isolate, or miss class for another reason, may still access our content. More information can be found here.

Accommodations: If you have an exam accommodation approved by the Student Accessibility Accommodations, you must let me know at least one week before the exam. Please contact me directly through email or Canvas.

Academic Integrity: The instructors of this course take Brown's Academic Code, and academic integrity in general, very seriously. Submitting dishonest work, whether on homework or exams, makes it more difficult to effectively help you and your fellow students learn, and it dilutes the meaning of a Brown degree.

It is your responsibility to understand what actions are allowed in this course, and what actions are violations of the Academic Code. Further information is available here. Any incidents that appear to violate course rules will be presented to, and adjudicated by, the university's Academic Code committee.

Use of Artificial Intelligence: The use of artificial intelligence is not strictly prohibited in this class, but it is strongly discouraged. As no electronic devices will be allowed on the exams, relying heavily on the use of supplementary resources seems disadvantageous for exam performance. Moreover, I have found that these programs frequently provide incorrect solutions to problems in our course.

Inclusivity and Equity: This course strives to be accessible and inclusive to all students, regardless of age, race, nationality, gender identity, sexual orientation, religion, economic background, or any other difference that contributes to the vibrant and diverse Brown community. We are committed to conducting all interactions with students with a sense of respect and equity. We ask that students interact with other students and instructors in this same spirit. If something happens to make you feel unwelcome or discriminated against, please bring it to our attention so that we can try to make the situation right.

In addition, Brown is committed to providing support for students with learning differences, physical impairments, and other disabilities. If you think you may need accommodations due to one of these conditions, contact Student Accessibility Services for more information.

Tentative Schedule:

Week 1: Jan 24 - Jan 26	Matrix Exponentials (no class Jan 22nd)
Week 2: Jan 29 - Feb 2	Matrix Groups & their smooth structures
Week 3: Feb 5 - Feb 9	Lie Algebras of Matrix Groups
Week 4: Feb 12 - Feb 16	Lie sub-algebras, ideals, sequences
Week 5: Feb 19 - Feb 23	Nilpotent and Solvable Lie Algebras
Week 6: Feb 26 - Mar 1	Low-dimensional nil/sol-geometry
Week 7: Mar 4 - Mar 8	S^3 and $\mathrm{SO}(3,\mathbb{R})$
Week 8: Mar 11 - Mar 15	$\mathrm{SO}(4,\mathbb{R})$ and $\mathrm{SO}(3,\mathbb{R}) \times \mathrm{SO}(3,\mathbb{R})$
Week 9: Mar 18 - Mar 22	Basic Riemannian geometry
Week 10: Mar 25 - Mar 29	Spring Recess :)
Week 11: Apr 1 - Apr 5	$\mathrm{PSL}(2,\mathbb{R})$ and some Hyperbolic Geometry
Week 12: Apr 8 - Apr 12	Fuchsian subgroups of $\mathrm{PSL}(2,\mathbb{R})$
Week 13: Apr 15 - Apr 19	Representations of finite groups
Week 14: Apr 22 - Apr 26	Finite subgroups of $\mathrm{SO}(3,\mathbb{R})$

Final Exam - May 9th 9:00 AM (EST)