

# PMATH 863 - Introduction to Lie Groups and Lie Algebras Winter 2021

Please note that some details below are subject to change.

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**Instructor:** Da Rong (Daren) Cheng

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This course is being offered online only. Lectures will be recorded and posted to Learn regularly. I'll try to keep each recorded lecture to around 30 minutes in length on average. There will be approximately 3 hours worth of lectures posted each week.

There will be a Piazza page for this course, and you are encouraged to post your questions there. I will do my best to respond within one business day. I might also hold regular office hours over MS Teams if there is enough demand, and of course you can always reach me by e-mail.

## **Prerequisites:**

I will assume familiarity with real analysis, linear algebra and group theory. Familiarity with functional analysis, complex analysis and smooth manifolds is helpful, but not required. You might appreciate some of the results better if you have seen the representation theory of finite groups, but again that is not required. *Last but not least, the course will move very rapidly. Students should be prepared to absorb a large amount of material at a fast pace.*

## **Tentative list of topics**

Matrix Lie groups; bilinear forms and the classical Lie groups; Lie algebras and the exponential map; correspondence between Lie groups and Lie algebras; the Baker-Campbell-Hausdorff formula. Representation theory; irreducible representations of  $SU(2)$  and  $SU(3)$ ; roots, weights and the Weyl group. Maximal tori in compact Lie groups; the Peter-Weyl theorem and completeness of characters; theorem of the highest weights.

*Possible additional topics if time permits:*

Applications to spherical harmonics and other special functions; Clifford multiplication and  $Spin(n)$ .

## **Textbooks**

*"Lie Groups, Lie Algebras and Representations (2nd ed.)"* by Brian C. Hall.

Hall's book is available online through UWaterloo library. I plan to cover most of Chapters 1 through 6 plus Chapters 11 and 12, as well as some additional material from this book and from other sources.

Some other useful references:

*"Compact Lie Groups"* by Mark. R. Sepanski.

*"Representations of Compact Lie Groups"* by Theodore Brocker & Tammo tom Dieck.

I checked recently and both titles should be available via UWaterloo library.

**Grading Scheme:**

There will be six assignments, due approximately every two weeks, and a final assessment. Details to be determined.