

Math 547 – Lie Algebras and Representation Theory

Fall 2024

Instructor: Martha Precup

Office: Cupples I, Room 203A

Email: martha.precup@wustl.edu

Meeting Time: MWF at 12:00-12:50pm in Cupples I, Room 215

Course Website: Canvas

Course Content: An introduction to Lie algebras and representation theory. The course has two main parts:

1. **Lie algebras and their structure.** An introduction to the structure of solvable and semisimple Lie algebras. Concrete examples of the classical Lie algebras \mathfrak{sl}_n , \mathfrak{sp}_n and \mathfrak{so}_n will be stressed throughout. This will be followed by an account of the general theory of semisimple Lie algebras, whose classification reduces to that of the finite root systems.
2. **Representation theory.** An introduction to the representation theory of complex semisimple Lie algebras. Universal enveloping algebras and Poincaré–Birkhoff–Witt Theorem followed by the classification theorem. Time permitting, we will discuss computational tools such as Kostant’s multiplicity formula, Weyl’s formula, and Steinberg’s formula.

Homework: Completing written assignments plays a key role in learning the material. One or two exercises will be assigned based on the material of each lecture. Solutions will be collected using Gradescope. If your proof is based on an idea you read or heard about from someone else, a textbook, or an on-line resource then *you must cite your sources*. There will be four problem sessions throughout the course of the semester before assignment deadlines.

1. **Problem session:** Friday, September 20 ; **HW Deadline:** Tuesday, September 24
2. **Problem session:** Friday, October 11; **HW Deadline:** Tuesday, October 15
3. **Problem session:** Friday, November 1; **HW Deadline:** Tuesday, November 4
4. **Problem session:** Friday, November 22; **HW Deadline:** Tuesday, November 26

Attendance and active participation is expected.

Presentations: Every student will give a 20-minute presentation on a topic related to course material. These topics can come from research papers or textbooks. In some cases, an expository article may be appropriate. Suggested papers and ideas will be posted on Canvas throughout the semester. You will also provide presentation feedback for your classmates. *All students must schedule their presentation (even if they aren’t certain of the topic) by Monday, November 18.*

Textbooks: The two main references for this class are marked by (*).

- (*) *Introduction to Lie Algebras*, by K. Erdmann and M. J. Wildon (available online via Springerlink)
- (*) *Introduction to Lie Algebras and Representation Theory*, by J. Humphreys (3 copies online via WUSTL library)

- *Representation Theory: A First Course*, by W. Fulton and J. Harris (available online via Springerlink)
- *Symmetry, Representations, and Invariants*, by R. Goodman and N. R. Wallach (available online via Springerlink)

Grading Policy: Homework (25%), attendance and participation (50%), and presentation (25%).

Health and Wellness: If you are unable to participate in the course due to illness, then please let me know. Reasonable accommodations will be made. There are many resources on-campus to support your learning and health; see <https://students.wustl.edu/all-resources/>.

Syllabus Resources from the Office of the Provost:

<https://provost.wustl.edu/syllabi-resources-and-template-language-danforth-campus/>

Beyond this course: You matter more than this class. Do not sacrifice your mental health, your access to material resources, or who you love. Make time for what you enjoy. Analogous statements hold for your professor.