

MATH-518

Ergodic theory

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Cursus	Sem.	Type
Ing.-math	MA2, MA4	Opt.
Mathématicien	MA2	Opt.

Language of teaching	English
Credits	5
Session	Summer
Semester	Spring
Exam	Oral
Workload	150h
Weeks	14
Hours	4 weekly
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This is an introductory course in ergodic theory, providing a comprehensive overlook over the main aspects and applications of this field.

Content

In the broadest sense, ergodic theory is the study of group actions on measure spaces. Its history traces from Poincaré's recurrence theorem in celestial mechanics and Boltzmann's ergodic hypothesis in statistical physics to its mathematical proliferation in the 1930s through the ergodic theorems of von Neumann, Birkhoff, and Koopman. It has since grown into a hugely important research area with striking applications to other areas of mathematics. This course provides an introduction to the basics of ergodic theory. Among other things, this includes the theory of recurrence, the structure and convergence of ergodic averages, and the notion of entropy. We will motivate the main ideas and results through simple examples. Another focal point lies on the many groundbreaking applications of ergodic theory in number theory.

Keywords

ergodic theory, dynamical systems, measure-preserving transformation, entropy

Learning Prerequisites**Recommended courses**

Measure and integration

Important concepts to start the course

This course is aimed at master's or advanced bachelor's students. Since ergodic theory is largely based on the notions of measure theory, either some background in measure theory or the willingness to learn some of this material along the way is expected. I will provide a handout summarizing the prerequisites from measure theory that are needed for this course at the beginning of the semester.

Learning Outcomes

By the end of the course, the student must be able to:

- Formalize dynamical ideas and concepts such as ergodicity, entropy, chaos, determinism, etc.
- Apply tools and techniques from ergodic theory in number theory and combinatorics
- Interpret examples of dynamical systems
- Prove results in ergodic theory

Transversal skills

- Use a work methodology appropriate to the task.
- Demonstrate a capacity for creativity.
- Demonstrate the capacity for critical thinking
- Continue to work through difficulties or initial failure to find optimal solutions.

Teaching methods

in-person lectures, in-person exercise sessions with the teaching assistant

Assessment methods

oral exam

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

Resources

Bibliography

- M. Einsiedler, T. Ward, *Ergodic Theory with a view towards Number Theory*, Springer-Verlag London, 2011.
- P. Walters, *An Introduction to Ergodic Theory*, Graduate Texts in Mathematics, Springer New York, 1982.

Ressources en bibliothèque

- [An Introduction to Ergodic Theory / Walters](#)
- [Ergodic Theory with a view towards Number Theory / Einsiedler](#)

Notes/Handbook

Lecture notes will be provided

Moodle Link

- <https://go.epfl.ch/MATH-518>