

Studierendenseminar WS 2025: Reversible Markov Chains and Electrical Networks

Talks can be given in German or English. About two weeks before your talk, please meet with Paul Klass (pklass2@uni-koeln.de) in order to discuss the planned structure of your talk as well as possible questions regarding the material. Talks can be given using slides or blackboard and should roughly be about 60 minutes including questions. The material for each talk might span more material than is actually possible to cover during 60 minutes. You should therefore try to focus on the most relevant parts.

On the one hand, the preparation will presumably require reading a little bit through further sources for background. On the other hand, you are not expected to produce a written handout or summary for your presentation.

The in-person meetings will start on October 22. The level of difficulty somewhat increases along the seminar, so generally speaking talks in the first half are more suitable for BSc students, while talks in the second half are slightly more directed towards MSc students.

Main source:

- Russell Lyons and Yuval Peres, *Probability on Trees and Networks* [LP16]

Further reading:

- David Levin and Yuval Peres, *Markov chains and mixing times* [LP17]
- Asaf Nachmias, *Random Walks and Electric Networks* [Nac20]
- Peter Doyle and J. Laurie Snell, *Random Walks and Electric Networks* [DS84]

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Preliminary reading

- [LP16] Chapter 1

2

Talk 1 (Oct 22): Circuit Basics and Harmonic Functions

- [LP16] Pages 18 to 24 (until end of Section 2.1)

3

Talk 2 (Oct 29): More Probabilistic Interpretations

- [LP16] Pages 24 to 27 (until end of Section 2.2)

4

Talk 3 (Nov 5): Network Reduction

- [LP16] Pages 27 to 31 (until end of Section 2.3)

5

Talk 4 (Nov 19): Energy

- [LP16] Pages 31 to 36 (until end of Section 2.4)

6

Talk 5 (Nov 26): Transience and Recurrence

- [LP16] Pages 36 to 43 (until end of Section 2.5)

7

Talk 6 (Dec 3): Rough Isometries and Hyperbolic Graphs

- [LP16] Pages 43 to 48 (until end of Section 2.6)

8

Talk 7 (Dec 10): Hitting, Commute, and Cover Times

- Pages 48 to 49 (until end of Section 2.7) including Exercise 2.20 (see Prop. 11.4 [LP17])

9

Talk 8 (Dec 17): The Canonical Gaussian Field

- [LP16] Pages 50 to 52 (until end of Section 2.8)

Literatur

- [DS84] Peter G. Doyle and J. Laurie Snell. *Random walks and electric networks*, volume 22 of *Carus Mathematical Monographs*. Mathematical Association of America, Washington, DC, 1984.
- [LP16] Russell Lyons and Yuval Peres. *Probability on trees and networks*, volume 42 of *Cambridge Series in Statistical and Probabilistic Mathematics*. Cambridge University Press, New York, 2016.
- [LP17] David A. Levin and Yuval Peres. *Markov chains and mixing times*. American Mathematical Society, Providence, RI, second edition, 2017. With contributions by Elizabeth L. Wilmer, With a chapter on “Coupling from the past” by James G. Propp and David B. Wilson.
- [Nac20] Asaf Nachmias. *Random Walks and Electric Networks*, pages 11–31. Springer International Publishing, Cham, 2020.