

COM-417

**Advanced probability and applications**

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Cursus	Sem.	Type
Computer and Communication Sciences		Obl.
Computer science	MA2, MA4	Opt.
Cybersecurity	MA2, MA4	Opt.
Data Science	MA2, MA4	Opt.
Data science minor	E	Opt.
Electrical Engineering		Opt.
Robotics, Control and Intelligent Systems		Opt.
SC master EPFL	MA2, MA4	Obl.

Language of teaching	English
Credits	8
Session	Summer
Semester	Spring
Exam	Written
Workload	240h
Weeks	14
<b>Hours</b>	<b>6 weekly</b>
Courses	4 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Summary**

In this course, various aspects of probability theory are considered. The first part is devoted to the main theorems in the field (law of large numbers, central limit theorem, concentration inequalities), while the second part focuses on the theory of martingales in discrete time.

**Content**

- sigma-fields, random variables
- probability measures, distributions
- independence, convolution
- expectation, characteristic function
- random vectors and Gaussian random vectors
- inequalities, convergences of sequences of random variables
- laws of large numbers, applications and extensions
- convergence in distribution, central limit theorem and applications
- moments and Carleman's theorem
- concentration inequalities
- conditional expectation
- martingales, stopping times
- martingale convergence theorems

**Keywords**

probability theory, measure theory, martingales, convergence theorems

**Learning Prerequisites****Required courses**

Basic probability course  
Calculus courses

**Recommended courses**

Complex analysis

**Important concepts to start the course**

This course is NOT an introductory course on probability: the students should have a good understanding and practice of basic probability concepts such as: distribution, expectation, variance, independence, conditional probability.

The students should also be at ease with calculus. Complex analysis is a plus, but is not required.

On the other hand, no prior background on measure theory is needed for this course: we will go through the basic concepts one by one at the beginning.

### Learning Outcomes

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

- understand the main ideas at the heart of probability theory

### Teaching methods

Ex cathedra and flipped lectures + exercise sessions

### Expected student activities

active participation to exercise sessions

### Assessment methods

graded homeworks 20%

midterm 20%

final exam 60%

### Resources

#### Bibliography

Sheldon M. Ross, Erol A. Pekoz, A Second Course in Probability, 1st edition, [www.ProbabilityBookstore.com](http://www.ProbabilityBookstore.com), 2007.

Jeffrey S. Rosenthal, A First Look at Rigorous Probability Theory, 2nd edition, World Scientific, 2006.

Geoffrey R. Grimmett, David R. Stirzaker, Probability and Random Processes, 3rd edition, Oxford University Press, 2001.

Richard Durrett, Probability: Theory and Examples, 4th edition, Cambridge University Press, 2010.

Patrick Billingsley, Probability and Measure, 3rd edition, Wiley, 1995.

#### Ressources en bibliothèque

- [Probability and Random Processes](#)
- [Sheldon M. Ross, Erol A. Pekoz, A Second Course in Probability, 1st ed](#)
- [Patrick Billingsley, Probability and Measure, 3rd ed](#)
- [Richard Durrett, Probability: Theory and Examples, 4th ed](#)
- [Jeffrey S. Rosenthal, A First Look at Rigorous Probability Theory, 2nd ed](#)

#### Notes/Handbook

available on the course website

#### Websites

- <https://moodle.epfl.ch/course/view.php?id=14557>

#### Moodle Link

- <https://go.epfl.ch/COM-417>

### Prerequisite for

Advanced classes requiring a good knowledge of probability