M119	Stochastic Processes I	L	P	S	ECTS
		2	2	0	6

Course objectives. Adoption of theoretical concepts related to basic types of discrete-time stochastic processes, understanding of analytical techniques for solving problems in theory and practice, and identifying possible applications of stochastic processes in practice.

Prerequisites. Undergraduate degree in Mathematics or related undergraduate degree.

Course content.
1. Definition of a stochastic process. Types of stochastic processes. Examples of stochastic processes in discrete time.
2. Discrete-time Markov chains. Definition and basic properties (initial distribution, transition probability function and matrix of transition probabilities). Important examples. Higher order transition probabilities. Chapman – Kolmogorov equations. State space decomposition to classes of communication. Absorption probabilities. Strong Markov property. Recurrence and transience. Canonical decomposition (on return classes and transient states). Periodicity. Stationary distribution and invariant measure. Limiting distribution. Ergodic theorem.
3. Discrete-time martingales and their properties. Previsible (predictable) processes. Martingale transformation. Stopping time. Important examples and applications.

No.	LEARNING OUTCOMES
1.	Explaining the concept of a stochastic process.
2.	Differentiating between different types of stochastic processes.
3.	Explaining the probabilistic properties of stochastic processes and the possibilities of their applications.
4.	Using probability theory techniques and tools for proving of properties of discrete-time stochastic processes.
5.	Identifying practical phenomena suitable for discrete-time modelling by Markov chains and martingales.
6.	Solving problems related to the application of discrete-time stochastic processes in practice and interpreting solutions.
7.	Combining concepts and methods from course content for solving more complex problems.

RELATING THE LEARNING OUTCOMES, ORGANIZATION OF THE EDUCATIONAL PROCESS AND ASSESSMENT OF THE LEARNING OUTCOMES

TEACHING ACTIVITY	ECTS	LEARNING OUTCOME **	STUDENT ACTIVITY*	EVALUATION METHOD	POINTS	
					min	max
Attending lectures and exercises	1.5	1-7	Lecture attendance, discussion, team work, independent work on given tasks and short examination	Attendance lists, tracking activities	0	5
Homework	0.5	4-7	Solving theoretical and practical problems	Evaluation	0	5

Written exam (Mid-terms)	2	1-5	Preparing for written exam	Evaluation	30	60
Final exam	2	1-7	Revision	Oral exam	20	30
TOTAL	6				50	100

Teaching methods and student assessment. Lectures and exercises are obligatory. The final exam is oral, taken after the completed lectures and exercises and achieved minimum number of credits at the midterm exams. Students can influence the grade by writing homework during the semester.

Can the course be taught in English: Yes

Basic literature:

1. R. Durrett, Essentials of Stochastic Processes, Springer, 2016.
2. G. Grimmett, D. Stirzaker, Probability and Stochastic Processes, Clarendon Press, Oxford, 2004.

Recommended literature:

1. P. Baldi, L. Mazliak, P. Priouret, Martingales and Markov Chains: Solved Exercises and Elements of Theory, Chapman and Hall, New York, 2002.
2. N. Elezović, Statistika i procesi, Element, Zagreb, 2007.
3. S. Karlin, H. M. Taylor, A First Course in Stochastic Processes, Academic press, New York-London, 1975.
4. J. R. Norris, Markov Chains, Cambridge University Press, 1997.
5. S. I. Resnick, Adventures in Stochastic Processes, Birkhauser, Boston, 2002.
6. S. M. Ross, Introduction to Probability Models, Academic Press, 2014.
7. Z. Vondraček, Markov Chains (web material in croatian), Faculty of Natural Sciences - Department of Mathematics, University of Zagreb, 2018.
8. Z. Vondraček, Stochastic Processes (web material in croatian), Faculty of Natural Sciences - Department of Mathematics, University of Zagreb, 2018.
9. D. Williams, Probability with Martingales, Cambridge University Press, 2001.