I065	**Randomized algorithms**	L	P	S	ECTS
		2	2	0	6

Course objectives. Students will be introduced to fundamentals of probabilistic analysis and its applications in randomized algorithms. Qualify students for designing of randomized algorithms for different problems. Students will implement randomized and deterministic algorithms for given problems and make empirical evaluation of their correctness and efficiency.

Prerequisites. Undergraduate university study programme of mathematics and/or computer science.

Course content.

1. Introduction to randomized algorithms. Computation model. Randomized computation complexity classes. Randomized algorithm for min cut problem in graphs
2. Discrete random variables and expectation. Conditional expectation. The Coupon Collector problem.
3. Moments and deviations. Markov inequality. Randomized algorithm for computing median
4. Chernoff bounds. Coin tossing problem. Hoeffding bounds. Packet routing in sparse networks.
5. Birthday paradox. Bloom filters. Random graph models. Randomized algorithm for Hamilton cycle in random graphs
6. Probabilistic methods: counting argument, expectation argument. Derandomization using conditional expectation. Lovasz local lemma. Edge-disjoint paths in graph.
7. Markov chain. Randomized algorithms for 2-SAT, 3-SAT problems. Random walks in undirected graphs and connectivity problems
8. Continuous distributions and Poisson process. Continuous Markov chains. Markov queues.
9. Entropy as a measure of randomness. Compression and coding.
10. Monte Carlo methods. Problem of counting satisfiability solutions to disjunctive normal form. Monte Carlo and Markov chain: Metropolis algorithm.

LEARNING OUTCOMES

No.	LEARNING OUTCOMES
1.	Describe basic notions from probability theory and randomized complexity
2.	Design randomized algorithms for different problems which can be efficiently solved deterministically.
3.	Analyse correctness and efficiency of randomized algorithms using probabilistic analysis framework
4.	Analyse algorithm correctness using high probability argument
5.	Apply probabilistic methods to determine existence of combinatorial structure properties in given problem
6.	Explain foundations of Markov chains and Monte Carlo methods and apply in on problem modelling.
7.	Implement randomized algorithm in chosen programming language

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	1-7	Lecture attendance, discussion, teams work, independent work on given tasks and short written exams	Attendance lists, tracking activities, closed form exercises	0	0
Homework assignments	1	1-7	Independent work on given problems	Evaluation	0	20
Written exam (Mid-terms)	2	1-6	Preparing for written exam	Evaluation	25	40
Final exam	2	1-6	Revision	Oral exam	25	40
TOTAL	6				50	100

Teaching methods and student assessment. Lectures and exercises are obligatory. The exam consists of a written and an oral part. Upon completion of the course, students can take the exam. Successful midterm exam scores replace the written exam. Exercises are both auditory and laboratory. Laboratory exercises include the usage of computers. Students can improve their grades by writing homework assignments and seminars.

Can the course be taught in English: Yes

Basic literature:

1. M. Mitzenmacher, E. Upfal, Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis, 2Ed, Cambridge University Press, 2017
2. R. Motwani, P. Raghavan, Randomized algorithms, Cambridge University Press, 1995

Recommended literature:

1. S. M. Ross, Introduction to Probability Models, 11th Ed, Academic Press, 2014
2. C. H. Papadimitriou, Computational Complexity, Addison-Wesley, 1994.