Study program: Mathematics (Ph.D. program)

Course: Theory of Algorithms

Course instructor(s): Siniša Crvenković

Course type (compulsory/elective): elective

Credit points: 10 ECTS

Prerequisites: -

Course objectives:

Introduction of the basic concepts, results and techniques of the theory of algorithms.

Learning outcomes:

Learning general methods and notions which enable applications of the theory of algorithms in research work in algebra, logic, discrete mathematics and theoretical computer science.

Course description (outline):

Church's thesis. Fundamentals of the theory of recursive functions. Recursive and recursively enumerable sets. Decidability. Formal arithmetic and Gödel's theorems. Turing machines and their languages. Turing decidable and Turing recognizable languages. The universal Turing machine and the halting problem. Rice's theorem. Equivalent models: multi-tape Turing machines and RAM machines. Computational complexity. Time and space complexity. Complexity classes. The SAT problem. Graph algorithms. Matching. Reductions and completenes in complexity classes. The P=NP question. Examples of NP-complete problems. The class coNP. Polynomial hierarchy. Space complexity. Savich's theorem. Classes L and NL. The class PSPACE. PSPACE-complete problems, winning strategies in games, interactive protocols. Turing machines with oracle. Degrees of unsolvability. Arithmetic and analytic hierarchies of undecidable problems. Algorithmc problems in universal algebra. Decidability of the elementary, quasy-equational and equational theory of a variety. The word problem.

References:

1. A.I.Mal'cev, *Algorithms and Recursive Functions*, Wolters-Noordhoff, Groningen, 1970.
2. H.Hermes, *Enumerability, Decidability, Computability*, Springer-Verlag, Berlin, 1965.
3. T.H.Cormen, C.E.Leiserson, R.L.Rivest, *Introduction to Algorithms*, MIT Press, Cambridge, 1990.
4. D.C.Kozen, *Automata and Computability*, Springer-Verlag, 1997.
5. M.R.Garey, D.S.Johnson, *Computers and Intractability: a Guide to the Theory of NP-completeness*, W.H.Freeman, San Francisco, 1979.
6. D.E.Knuth, *The Art of Computer Programming*, Vol. I--III, Addison-Wesley, Reading, 1973.
7. C.H.Papadimitriou, *Computational Complexity*, Addison-Wesley, Reading, 1994.
8. M.Sipser, *Introduction to the Theory of Computation*, PWS Publishing Co., Boston, 1997.
9. И.Долинка, *Кратак увод у анализу алгоритама*, ПМФ, 2008.
10. R.E.Tarjan, *Data Strucures and Network Alhorithms*, Regional Conference series in Applied Mathematics, Vol.44, SIAM, Philadelphia, 1983.

Active teaching hours	**Theoretical classes:** 2	**Practice classes:** -6

Methods of teaching:

Lectures, with active participation of the students, discussion, etc.

Grading structure

Pre-exam obligations	**Points**	**Exam**	**Points**
Colloquia	**50**	Oral exam	**50**
Seminars			