Study programmes: PhD studies – Mathematics

Course name: Algebraic combinatorics, computability theory and computational complexity theory

Lecturers: Zoran Petrović

Status: Optional

ECTS: 9

Attendance prerequisites: None

Course aims: Acquisition of general knowledge of algebraic combinatorics, computability theory and computational complexity theory.

Course outcome: Upon completion of the course, students have acquired relevant theoretical knowledge and are qualified to solve problems from the mentioned areas.

Course content:

1. Algebraic combinatorics: Symmetries of combinatorial objects. Operations on groups. Coherent configurations and association schemes. Symmetric graphs, examples, construction, structural properties. Combinatorial maps and their symmetries. **2. Computability theory:** Church's thesis and efficient computability. Model of computation. Examples of computable functions. Primitive recursive functions. Numbering of a computable function, SMN and UTM theorems. Decidable and undecidable sets, undecidable problems. **3. Computational complexity theory:** Time and space complexity. Linear speedup theorem. Deterministic simulation. P and NP problems. Reductions to problems of polynomial complexity. NP-completeness. Cook-Levin theorem. NP-complete problems.

Literature:

N. L. Biggs, *Algebraic Graph Theory,* Cambridge Univ. Press, 1994.
N. L. Biggs, A. T. White, *Permutation Groups and Combinatorial Structures,* Cambridge Univ. Press, 1979.
W. Bosma, J. Cannon, C. Playoust, *The MAGMA Algebra System I: The User Language,* J. Symbolic Comput. 24 (1997) 235-265.
P. J. Cameron, *Permutation Groups,* LMS Student Text 45, Cambridge Univ. Press, Cambridge, 1999.
J. D. Dixon, B. Mortimer, *Permutation Groups,* Springer-Verlag, New York, 1996.
C.D. Godsil, *Algebraic Combinatorics*, Chapman & Hall, 1993.
C. Godsil, G. Royle, *Algebraic Graph Theory,* Springer, New York, 2001.
H. Wielandt, *Finite Permutation Groups*, Academic Press, New York, 1964.
The GAP Group, *GAP - Groups, Algorithms, and Programming,* Version 4.4.12; 2008. (http://www.gap-system.org).
H. Lewis, C. Papadimitriou, *Elements of the theory of computation,* Prentice Hall, 2nd ed. 1998.
M. Sipser, *Introduction to the theory of computation,* PWS Publishing company, 1997.
R. Sommerhalder, S. C. Van Westrhenen, *The Theory of Computability: Machines, Effectiveness and Feasibility,* Addison Wesley 1987
Cooper, S. Barry, *Computability theory,* CRC PRESS, 2003
N. Cutland, *Computability: An introduction to recursive function theory,* Cambridge Univerity Press, 1980
H. Rogers, *Theory of recursive functions and effective computability,* McGraw Hill, 1967
R. I. Soare, *Recursively enumerable sets and degrees*, Springer, 1987.

Number of hours: 10	**Lectures:** 4	**Tutorials:** 6

Teaching and learning methods: Frontal / Interactive / Tutorials / Lectures / Exercises

Assessment (maximal 100 points)

Course assignments	Points	Final exam	Points
Lectures	-	Written exam	30
Exercises / Tutorials	-	Oral exam	30
Colloquia			
Essay / Project	40		