CORES

# DOC-COURSE 2014

October – December

DIMATIA

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# Structural Graph Theory

Vybrané Kapitoly z Kombinatoriky I/
Selected Chapters in Combinatorics NDMI055

Guarantor: J. Nešetřil, A. Goodall Assistant: L. Vena Cros

*The course starts in the week beginning 6 October, by which time the exact schedule will be determined.*

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Lecturers:

**Prof. J. Makowsky**
(Technion - Israel Institute of Technology, Haifa)

**Prof. M. DeVos**
(Simon Fraser University, Vancouver)

**Dr G. Kun**
(ELTE, Budapest)

**Prof. M. Pinsker**
(Technische Universität Wien/ Université Diderot - Paris 7)

**Dr L. Zdeborová**
(CEA & CNRS, Saclay)

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Intended audience:

*Graduate students and postdocs of Mathematics or Computer Science, with an interest in graph theory, Ramsey theory, the interaction of combinatorics with logic and mathematical physics, and related fields. Students at other universities (domestic and abroad) are welcome. Financial assistance is possible: please write to andrew@kam.mff.cuni.cz*

*Students taking the KAM/ IÚUK course Vybrané Kapitoly z Kombinatoriky I (Selected Chapters in Combinatorics) select at least two of the special lectures and write an exam in the form of a project. Complementing the special lecture series will be lectures given by Prof. Nešetřil and Dr Goodall.*

# Titles and Abstracts

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**Prof. Johann Makowsky**

*Classical graph properties and graph parameters and their definability in SOL*

Intriguing graph polynomials. Why is the chromatic polynomial a polynomial?
Comparing graph polynomials. On connection matrices and their use in showing non-definability.

**Prof. Matt DeVos**

*Flows on bidirected graphs*
*Immersion and embeddings of 2-regular digraphs*

**Dr Gábor Kun**

*An analytic approach to CSPs*

Analytic version of the dichotomy conjecture, connection to notions in discrete Fourier analysis. Proof of the Hell-Nesetril theorem using Dinur-Friedgut-Regev (on independent sets in power graphs).

**Prof. Michael Pinsker**

*Algebraic and model-theoretic methods in constraint satisfaction*

The Constraint Satisfaction Problem (CSP) of a finite or countable first-order structure S in a finite relational language is the problem of deciding whether a given conjunction of atomic formulas in that language is satisfiable in S. Many classical computational problems can be modelled this way. The study of the complexity of CSPs involves an interesting combination of techniques from universal algebra, Ramsey theory, and model theory. This tutorial will present an overview over these techniques as well as some wild conjectures.

**Dr Lenka Zdeborová**

*Coloring random and planted graphs:*
*Thresholds, structure of solutions, algorithmic hardness*

Random graph coloring is a key problem for understanding average algorithmic complexity. Planted random graph coloring is a typical example of an inference problem where the planted configuration corresponds to an unknown signal and the graph edges to observations about the signal. Remarkably in a recent decade or two tremendous progress has been made on the problem using (principled, but mostly non-rigorous) methods of statistical physics. We will describe the methods - message passing algorithms and the cavity method. We will discuss their results - structure of the space of solutions, associated algorithmic implications, and corresponding phase transitions. We will conclude by summarizing recent mathematical progress in making these results rigorous and discuss interesting open problems.