

Combinatorics

1. Fundamental techniques in discrete mathematics (counting the number of functions, permutations, subsets, etc.), Catalan numbers, inclusion-exclusion principle.
2. Hall's marriage theorem and its applications to Latin rectangles and tournaments (Landau's theorem). Bell numbers, Stirling numbers of the first and second kind and some relations between these numbers.
3. Latin squares and their basic properties.
4. Theorems concerning Latin square extensions. Recently solved problems about Latin squares extensions (Dinitz conjecture, Evans' conjecture).
5. Mutually orthogonal Latin squares. Definition of the number $N(n)$ and its properties.
6. Ramsey's theorem (finite and infinite version). Definition of the Ramsey number.
Well known bounds for the Ramsey numbers. Some examples of Ramsey numbers ($R(3,3)$, $R(3,4)$).
7. Partition theorems: Hales–Jewett theorem, Van der Waerden's theorem, Schur's theorem and sum-free sets, Szemerédi's theorem (without proof).
8. Matroids and greedy algorithms. Some unsolved problems in combinatorics, for example: the Frankl conjecture, Erdős conjecture on arithmetic progressions, etc.
Open problems in Ramsey theory.