Andrew Lohr
Oral Exam Syllabus

Basics

- Binomial coefficients and their identities, inclusion-exclusion, Stirling's formula, Catalan numbers, Generating functions.

- Recurrences: solution of linear recurrences, Master Theorem.

- Posets, Birkhoff representation theorem, Dilworth's theorem.

- Ramsey theory: Ramsey's theorem for graphs and hypergraphs, upper and lower bounds, van der Waerdens theorem, Canonical Ramsey theorem.

- Beck-Fiala Theorem, six standard deviations suffice

- Sperner's theorem, LYM inequality, Erdos Ko Rado, Kruskal Katona

Graph Theory

- Hall's theorem, Tutte's theorem, Konig's theorem

- Graph Algorithms, DFS, BFS, strongly connected components, Topological sort, Dijkstra, Bellman-Ford.

- Flow networks, Ford-Fulkerson, interpretation as a linear program.

- Euler's Formula, Kuratowski's theorem, Wagner's theorem

- Turan's theorem, Szemeredi Regularity Lemma, Erdos-Stone theorem

- 5-color theorem, Brook's theorem, Vizing's theorem, Choice Number, Perfect graphs

Probabilistic Method

- Linearity of Expectation

- Markov's Inequality, Chebyshev's inequality, Chernoff bounds, FKG inequality

- Alteration method

- Lovasz local lemma, symmetric and asymmetric versions

- Martingales: Definition, Azuma's inequality, vertex and edge exposure.

Complexity

- P vs NP, Cook Levin Theorem, reductions, and approximation algorithms

- Diagonalization, Ladner's theorem

- Space bounded complexity, TQBNF, Savich's theorem, Immerman's Theorem

- Polynomial Hierarchy, Sipser-Gács Theorem

- Interactive proofs, IP, AM

- Circuit complexity

- Randomiaztion, RP

Algorithms

- Matroids, greedy algorithms, reductions to Matriod intersection and Matroid partition

- Ammortized Analysis

- Dynamic programming

- Linear programming, duality, integer linear programming, weak duality

- Fast Fourier Transform