1 Combinatorics I & II

Basic Enumeration

- Stirling numbers: $1^{st}, 2^{nd}$, unsigned
- Representations of Permutations
- Generating Functions

Principle of Inclusion–Exclusion

Partially Ordered Sets

- Dilworth's p.o. on {antichains}
- Dilworth's Thm
- Sperner's Thm

Lattices

- Distributive
  - Fund Thm Finite Distrib Lattices
- Geometric
  - Birkhoff Covering Property
  - Jordan–Dedekind Chain Condition

Closures

- Convex, Linear, Graphic, Ideal

Möbius Functions

- incidence algebra $I(P)$, ζ, μ
- Möbius Inversion
- Weisner's Thm
- Dowling–Wilson Thm

Hypergraphs

- Fisher's & Generalized Fisher's Inequality
- Nonuniform: Modular RC–W Thm

Extremal Problems for Finite Sets

- Intersecting Families
- Erdős–Ko–Rado Thm
- Shadows
  - Kruskal–Katona Thm
    - Numbers in KK
  - Lex Order, Upper Shadow
- Turán's Thm
  - Turán–type Problem

Correlation Inequalities

- Positively Correlated, Percolation
- Harris/Kleitman Thm
- Chebyschev's Inequality
- FKG Inequality
- Ahlswede–Daykin "Four Fcns Thm"
  - Applications to Posets

Ramsey Theory

- Ramsey on Graphs

  - Existence
  - Erdős Bound $R(k,k) > \frac{k2^{k/2}}{e\sqrt{2}}$
- General Ramsey (on Hypergraphs)
- Infinite Ramsey

2 Graph Theory

Minimum Weight Spanning Tree

Matching Theory

- Bipartite
  - König's Thm
  - Hungarian Method
  - Hall's Thm
  - SDRs
  - Latin Rectangles
    * Gale–Ryser Thm
- Baranyai's Theorem
- Tutte's 1–factor Thm
- Berge's Thm

Max Flow Min Cut Theorem

Menger's Thm

Connectivity

Vertex Colorings

- Brook's Thm

Edge Colorings

- Vizing's Thm

Planar Graphs

- Euler's Formula
  - 5–color Thm (Bondy–Murty Proof)
- Kuratowski's Theorem

Matroids

- Independence, Circuit, Rank, Base and Closure Axioms
- Linear, Graphic, Cographic
- Union of Matroids
- Duality
  - Abstract Duals
  - Whitney's "Abstract Dual $\iff$ Planar" Thm
- Edmond's Intersection Thm
- Matroid Union Thm

Extremal Graph Theory

* Turán ... (Comb)
- Erdős–Stone Thm
- Szemeredi's Regularity Lemma

3 Probabilistic Methods

Chapters 1–6 and 8 in Alon–Spencer–Erdős