Math 108 Syllabus (Persi Diaconis, Jan Vondrak)

References: Don Knuth: The Art of Computer Programming, Volume 4A
Richard Stanley: Enumerative Combinatorics, Volume 1 (optional)

(*) if time allows

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Week 1: Introduction [Knuth p. 1-35]
- Latin squares, graphs, degrees, coloring
- Greedy vertex coloring
- Characterization of degree sequences

Week 2: Matching and coloring [wikipedia: topics as below]
- Hall's Matching Theorem, König's Theorem
- Stable Marriage, Gale-Shapley algorithm
- Edge coloring of bipartite graphs
- Galvin's list-edge-coloring of bipartite graphs (*)

Week 3: The Boolean cube and posets [wikipedia: topics as below]
- Sperner's theorem (the largest antichain in {0,1}^n)
- The Christmas tree pattern (covering by chains) [Knuth p. 457-459]
- Dilworth's theorem on chains and antichains
- Application to monotone subsequences

Week 4: Traversing the cube [Knuth 7.2.1.1]
- Gray codes
- de Bruijn sequences
- the Hadamard-Walsh transform

Week 5: Basics of Enumerative Combinatorics [Stanley 1.1, 1.2, 2.1]
- Binomial and multinomial coefficients, binomial theorem
- Generating functions, some examples
- Algebraic vs. combinatorial proofs of identities
- Inclusion-exclusion, counting derangements

Week 6: Permutations [Stanley 1.3, 2.2, Knuth 7.2.1.2]
- Statistics on permutations: cycles, inversions, descents
- Permutations with restricted positions
- Lexicographic generation of permutations
- Alphametics, the Sims table (*)

Week 7: Trees [Knuth 7.2.1.6]
- Binary trees and Catalan numbers
- Cayley's formula
- The matrix-tree theorem

Week 8: Partitions [Stanley 1.3, 1.4, Knuth 7.2.1.4]
- Partitions of an integer, Young diagrams
- Gray code for partitions
- Generating function of partitions
- Euler's pentagonal formula (*)

Week 9: Set partitions [Stanley 1.4, Knuth 7.2.1.5]
- The Twelvefold Way
- Stirling numbers, Bell numbers
- Generating functions and identities for set partitions
- Gray code for set partitions (*)

Week 10: Recap and some history
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