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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