Summary of Topics for Midterm

Asymptotics

- Relationship between polynomial, exponential, logarithmic time
- Big-Oh notation

Basic Proof Ideas

- Proof by Contradiction (Stable Matchings)
- Pigeon hole principle
- Algorithm Design by Induction
- Reductions

Graphs

- Relationship between degree and number of edges
- Cycles, trees
- Graph search (BFS, DFS)
- Algorithm for coloring (bipartite graphs)
- Directed graphs (topological sort)

Greedy Algorithms

- Interval Scheduling
- Interval Partitioning
- Minimum Spanning Trees and Cycle/Cut Properties
- Shortest Path Algorithms (Dijkstra)
- Union Find Data Structure

Divide and Conquer Algorithms

- Recurrences (Master Theorem)
- Binary Search, Merge-sort
- Approximation the Root of a Function
- Finding Closest Points
- Integer Multiplication
- Finding the k-th smallest element

Approximation Algorithms

- Write the cost of the solution of algorithm in terms of OPT
- Vertex Cover
- Set Cover

Dynamic Programming

- Design the recurrence using subproblems then write the program
  - Always characterize the optimum solution
- Weighted Interval Scheduling
- Sequence alignment
- Knapsack
- RNA secondary structure
- Longest path in a DAG
- Longest Increasing Subsequence
- Bellman-Ford Algorithms

Network Flows

- Ford-Folkerson Algorithms
- Max-Flow Min-Cut Theorem
- Notion of Reduction in Max-Flow applications
- Maximum Matching in Bipartite Graphs
- Hall’s Theorem
- Edge Disjoint Paths
- Image Segmentation
- Project Selection

NP

- Polynomial Time Reductions
  - Vertex Cover
  - Independent Set
  - Clique
  - Set Cover
- Class NP
- NP-hard and NP-Completeness