Comprehensive Syllabus for Discrete Mathematics

Graph Theory:

The Basics: graphs, paths and cycles, connectivity, trees and forests, bipartite graphs, contraction and minors, Euler tours, Hamilton Cycle. Diameter of trees and graphs, Spanning Trees.

Matching and Covers: Maximum bipartite matching algorithms, Hall's Theorem, Konig's Theorem, Independent Set and Covers, Dominating Sets. Matching in general graphs.

Cuts and Connectivity: Vertex-Connectivity, Edge-Connectivity, 2-connected Graphs, Menger's theorem

Network flow: The maximum flow problem and Ford-Fulkerson algorithm, Maximum flows and minimum cuts in network. Applications-Bipartite matching problem, Airline scheduling, Project Selection.

Planar Graphs: drawing, Euler's formula, Kuratowski's theorem, Wagner's Theorem, plane duality.

Coloring: coloring maps and planar graphs, Vertex Colouring and upper bounds, Greedy Colouring, Brooks' Theorem, Edge Colouring. Colouring Planar Graphs

Additional Topics: Cayley graph, Spectrum of a graph, Turan's Theorem, Ramsey Theorem, Ramsey Graphs, Perfect graphs

Algorithms:

Stable matching, Interval Scheduling, Weighted Interval Scheduling, Bipartite matching, Independent Set, Asymptotic order of growth: big O notation and its relatives.

Divide and Conquer and Recurrences: The master theorem, application to the complexity of recursive algorithms, Merge Sort, Median, The fast Fourier Transform.

Data Structures: Stacks, queues, priority queue, heaps, binary search trees.

Basic Algorithms: breadth first search, depth first search, DAGs (directed acyclic graphs) and topological ordering, strongly connected components

Greedy Algorithms: Interval scheduling, Dijkstra's algorithm for finding shortest paths in a graph, minimum spanning trees, Huffman codes for data compression

Dynamic Programming: Longest Increasing sub-sequences, Minimum Edit Distance, Chain matrix Multiplication, The Knapsack problem, Contiguous subsequence, Longest common string, Floyd-Warshall Algorithm, Bellman-Ford Algorithm, Independent set in trees, Weighted independent set in trees and narrow grids.

Randomized Algorithms: Global minimum cut, Divide and conquer algorithm for median and quick sort. Randomized approximation algorithm for 3-SAT, finding closest pair of points.

Linear programming: maximizing flow, bipartite matching, vertex cover, zero sum game. NP-complete problems: 3-SAT, Vertex Cover, Independent Set, Clique, TSP; Approximation Algorithms for vertex cover, TSP, Knapsack.

References:

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3. Modern Graph Theory: B. Bollobas (2008) Springer
4. Graph Theory: R. Diestel (2006) Springer
5. Graphs: C. Berge (1989) North-Holland
6. H. Cormen, C. E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, 2/e, MIT Press
7. J. Klienberg and Eva Tardos: Algorithm Design. 1st Edition. Addison Wesley, 2005. ISBN 0-321-2
8. S. Dasgupta, C. H.Papadimitriou, and U. V. Vaziran, Algorithms, McGraw-Hill Higher Education, 2006.