

Department of Computer Science and Engineering
National Sun Yat-sen University
First Semester of 2026 PhD Qualifying Exam

Subject : Algorithms

1. Please explain P, NP-hard, NP-complete problems as well as reduction. Then, prove that the vertex-cover problem is NP-complete. (20%)
2. Please explain how to use dynamic programming to solve the matrix multiplication problem that should include pseudocode, example, and descriptions. Note that this example requires at least four matrices. (20%)
3. Please give the definitions of the fractional and 0/1 knapsack problems. Please also present the greedy and dynamic programming algorithms for solving these two knapsack problems. (20%)
4. Please explain the amortized analysis technologies and show how to use aggregate analysis, accounting method, and potential method to analyze the costs of push, pop, and multipop operations in the stack algorithm. (20%)
5. Please explain why any comparison sort algorithm will need $\Omega(n \lg n)$ comparisons in the worst case. (10%)
6. Please explain the minimum spanning tree (MST) and how to solve it using the Kruskal's and Prim's algorithms. (10%)