- Write your answer in English or Korean. Use separate sheet of paper for each problem.
- Total sun of the scores below is 105 points. You need to get at least 60 points among those 105 points to get a Pass.

1. State a definition of P, NP, and NP-complete problems (15p). State the definition of approximation ratio of an approximation algorithm for a minimization problem (10p).

2. Solve any one of the following problems: 1) State the merge sort algorithm and prove that its running time is O(n log n). You can either use the Master theorem, or prove it directly. 2) State the randomized quick sort algorithm and prove that its expected running time is O(n log n). You cannot apply the Master theorem for this problem. 3) State the vertex cover problem (VC), and state a 2-approximation polynomial time algorithm of VC. Show that the algorithm is a 2-approximation algorithm. (20p)

3. State any one of the following algorithms (you don't need to write any proof): 1) Floyd's all pair shortest path algorithm. 2) Dijkstra's single source shortest path algorithm. 3) Prim's minimum spanning tree algorithm. (20p)

4. Define the flow network on a directed graph, and state the flow maximization problem. State the maxflow mincut theorem. Explain that flow maximization problem of a flow network can be expressed by a linear programming. (20p)

5. Solve any one of the following problems (you don't need to write any proof): 1) State the Maximum Independent Set problem, and explain that this problem can be expressed as a zero-one integer programming. 2) State the recursive formula for the Page Rank computation, or explain the Markov Chain on the Web graph that corresponds to the Page Rank. 3) State the RSA cryptography key generation method, encryption method and decryption method. 4) State the traditional marriage algorithm, and state what is a stable pairing. (20p)