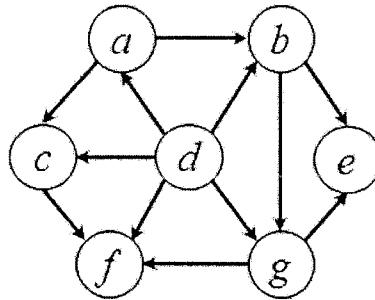# 國立臺灣師範大學 101 學年度碩士班招生考試試題

科目：軟體基礎　　　　　　　　　　適用系所：資訊工程學系

注意：1.本試題共 3 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則依規定扣 pts。

1. (5 pts) What does dynamic programming have in common with divide-and-conquer? What is a principal difference between the two techniques?

2. (a) (5 pts) Solve the topological sorting problem for the following graph.

(b) (5 pts) Give a condition where a topological sort cannot be achieved.

3. (a) (5 pts) Describe the Dijkstra's algorithm. What does the algorithm compute?

(b) (5 pts) Give a condition where the Dijkstra's algorithm is not applicable. Describe the condition with an example.

4. A *vertex cover* of an undirected graph $G = (V, E)$ is a subset $V' \subseteq V$ such that if (u, v) is an edge of G, then either $u \in V'$ or $v \in V'$ (or both). The *vertex-cover problem* is to find a vertex cover of minimum size in an undirected graph.
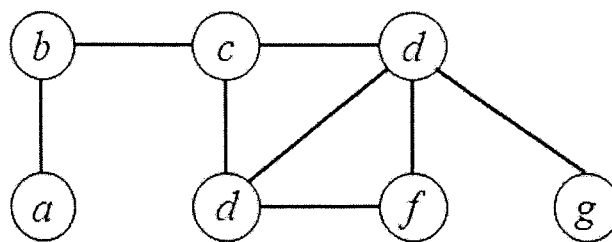
(a) (5 pts) What is the optimal vertex cover for the above graph?

(b) (10 pts) Consider the following greedy algorithm: repeatedly select a vertex of highest degree, and remove all of its incident edges. What is the vertex cover for the above graph returned by the algorithm? Does the algorithm have an approximation ratio less than or equal to 2? Give specific reasons for your answer; otherwise, no credit will be given.

5. (10 pts) At the beginning of day 1, there is a hen. A hen lays an egg every 24 hours. An egg takes 24 hours to become a hen. Let $F(n)$ be the number of hens at the end of day n, design an algorithm to compute $F(n)$. Justify the time and space complexity of your algorithm.

6. (10 pts) Which of the following sorting methods have $O(N \log N)$ time complexity in <u>average</u> case? Which of them also have $O(N \log N)$ time complexity in <u>worst</u> case?
   - Bubble sort
   - Selection sort
   - Insertion sort
   - Merge sort
   - Quicksort

7. (5 pts) Assume a <u>row-major</u> two-dimensional array A[1..N, 1..N] has N by N elements. The starting address of the array is S. Each array element is an integer of 4 bytes. Please show how to compute the address of A[i, j].

8. (5 pts) Please complete the following data type which represents a node of a double linked list.

```
struct node {
    int     value;
    ?       next;
    ?       previous;
};
```

9. (10 pts) Please write pseudocode that insert a new node (pointed by pNew) into the following double linked list, immediately after the node pointed by pCurrent.
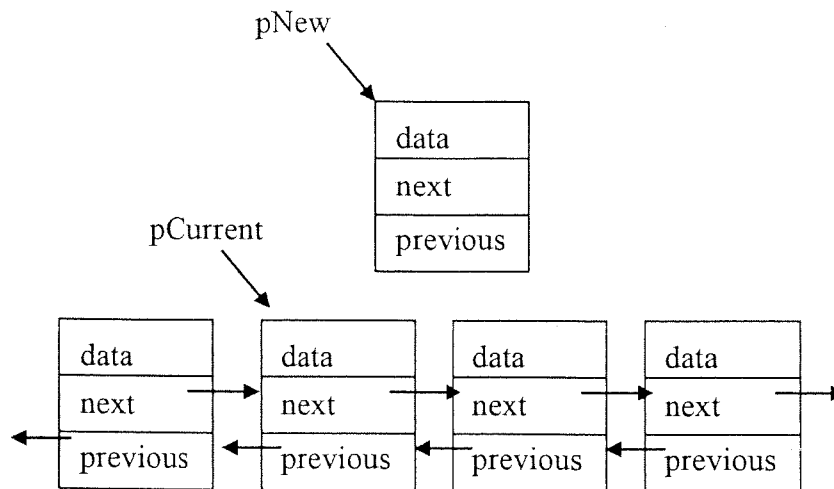
10. (10 pts) Please show the binary search tree after we insert 4, 2, 6, 1, 5, 7, 8 sequentially. Please also write the pseudo code to traverse the tree and output the numbers in ascending order.

11. Assume that a graph may be represented by an adjacency matrix G[i, j]. Please answer the following questions:

(a) (3 pts) What is the size of the array, if the graph has V vertices and E edges?

(b) (3 pts) What does the value in G[i, j] mean?

(c) (4 pts) How do you tell whether the graph is a directed graph or an undirected graph?