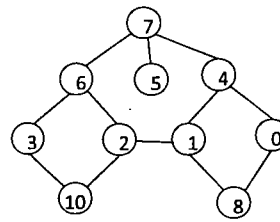所別： 資工類

科目： 資料結構與演算法

本科考試禁用計算器

＊請在答案卷（卡）內作答

複選題 (30%，每題5分，全對才給分，答錯倒扣1.25分)

倒扣到該大題 0 分為止。

1. Consider the graph below. Which of the following is a DFS traversal sequence starting from node 1?

   (A) 1 2 6 7 4 0 8 5 3 10
   (B) 1 8 0 4 7 5 6 3 10 2
   (C) 1 2 6 7 4 5 0 8 3 10
   (D) 1 4 0 8 7 6 3 10 2 5
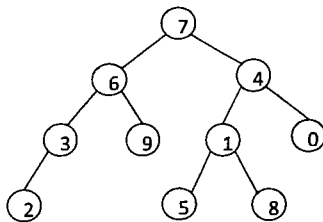

2. If a number 9 is inserted to the end of the Min-Heap below, and the heap is being reconstructed, which position will the 9 go?

Index:	0	1	2	3	4	5	6	7	8	9	10
Content:	6	8	15	10	17	16	23	20	22	18	40

   (A) A[0]   (B) A[1]   (C) A[2]   (D) A[5]
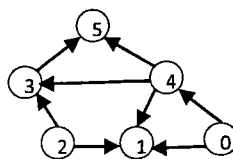
3. Given the following binary tree.

   If we make this binary tree a threaded binary tree, what nodes are pointed by threads of node 3?

   (A) node 6   (B) node 2   (C) node 7   (D) node 9

4. What orderings are topological sortings of the graph below?

   (A) 0 4 2 1 3 5 (B) 0 4 2 3 1 5 (C) 2 0 4 1 3 5 (D) 2 0 4 3 1 5

注意：背面有試題

5. Suppose that the result of the first partition step in quick sort is as follows.

   3　9　1　14　20　24　22　21

   Which of the following statements is true?

   (A) The pivot is either 14 or 20.

   (B) The pivot is 20.

   (C) Both 14 and 20 are pivots in the first partition.

   (D) The pivot is 14.

6. Consider an empty hash table with 11 buckets and each bucket has 2 slots.
   Suppose that linear probing is used to handle overflow, and the hash function: $h(n)$
   $= n$ % 11.

   Now we sequentially insert the following numbers into the hash table:

   6　16　22　44　53　24　45　7　74　4　109　78 12

   What is the summation of the numbers in the full buckets of the hash table?

   (A)294

   (B)216

   (C)225

   (D)201

是非題 (5%，每一題答對給 1 分、答錯倒扣 0.5 分)　倒扣到該大題 0 分為止。

7. The postfix expression, **bcd+*/aefg*+***, is valid.　(A) True.　(B) False.

8. Consider an adjacency matrix on a directed graph, the row sum is the in-degree,
   while the column sum is the out-degree.　(A) True.　(B) False.

9. An arbitrary graph with G(V; E), with | E| = | V |-1 edges is a binary tree.
   (A) True.　(B) False.

10. Depth-first search can be implemented by a stack.　(A) True.　(B) False.

注意：背面有試題

11. If $V(G') \subseteq V(G)$ and $E(G') \subseteq E(G)$, a graph G' is G's connected component.
    (A) True.   (B) False.

申論題 (65%)

1. (10%) Suppose that two stacks, stack 0 and stack 1, are both mapped to array mem[MEMORY_SIZE]. Algorithm PUSH adds an item into stack i, where $0 \le i < 2$, as long as the total number of items in these two stacks is less than MEMORY_SIZE− 1. Please complete algorithm PUSH.

```
int mem[MEMORY_SIZE];   /*global variable */
int top[2];     /*global variable */
void PUSH (integer item, integer i)
{


}
```

2. (5%) Below is the algorithm that produces all permutations of a set with n elements. Suppose the i-th element of the set is stored in list[i]. Please fill the two blankets to complete the algorithm.

```
void perm (char *list, int i, int n)
{
    int j, temp;
    if (i==n) {
        For (j=1; j<=n; j++)
            Printf("%c", list[j]);
    }
    else {
        For (_____) {
            SWAP(list[i], list[j], temp); /* swap list[i] and list[j] */

            _____

            SWAP(list[i], list[j], temp);
```

注意：背面有試題

```
      }
    }
  }
```

3. Consider the problem of finding minimum spanning tree (MST): Given a weighted undirected graph, find a spanning tree with the best (minimum) cost, where the cost of a spanning tree is the sum of the weights of its edges.

   a) (15%) Describe an efficient algorithm for solving this problem. You should also analyze the time complexity of this algorithm and describe the data structure used by the algorithm.

   b) (10%) Now assume that we also want to know a spanning tree with the second best cost (if there is any which may be same as the best cost). For example, consider the graph with vertex set {1, 2, 3} and edge set {(1, 2, 1), (1, 3, 1) (2, 3, 1)} where each triple (x, y, w) represents there is an edge with end vertices x, y, and weight w. Then the best and second best costs of spanning trees of this graph are both 2. For another graph with the same vertex set and edge set {(1, 2, 1), (1, 3, 2) (2, 3, 3)}, the best and second best costs of spanning trees of this graph are 3 and 4 respectively. Design an algorithm to solve this problem.

4. Given a set S of n real numbers, and another real number M, we want to determine whether or not there exist 3 numbers in S whose sum is exactly M. The algorithm of testing all possible 3 numbers in S will take $O(n^3)$ time and it is unacceptable.

   a) (10%) Design a more efficient algorithm to solve this problem. Analyze the time complexity of your algorithm.

   b) (5%) Consider the following similar problem: Given a set S of n real numbers, another real number M, and an integer k, we want to determine whether or not there exist k numbers in S whose sum is exactly M. Show that this problem is NP-Complete.

   c) (10%) If M is small enough, then it is possible to solve the above problem efficiently in $O(nkM)$ time. Design such an algorithm.

參考用