※ 考生請注意：本試題不可使用計算機

一、Data Structures (50%)

1. (20%) The following two functions show how to add and delete one element from a circular queue with capacity equal to N.

```
Initially, Head = Tail = 0;
Procedure AddQ(item, Q, N, Head, Tail)
    Tail ← (Tail + 1) mod N;
    IF   Head == Tail   then assert ("Queue Full") and exit
    Q(Tail) <- item
End AddQ
Procedure DeleteQ(item, Q, N, Head, Tail)
    IF   Head == Tail   then assert ("Queue Empty") and exit
    Head ← (Head+1) mod N
    Item ← Q(Head)
End DeleteQ
```

(a) When the "Queue Full" message is asserted in the procedure AddQ, one available space still exists in the queue. Why can't we use this space? (10%)

(b) Please modify the procedures so as to use such space. (10%)

2. (15%) The content of an array is shown as follows.

A[1]=18, A[2]=24, A[3]=1, A[4]=5, A[5]=90, A[6]=0, A[7]=8

When it is sorted by the following methods, please show the result of A[2] after the specific pass.

(a) Bubble sort (after the third pass) (5%)

(b) Shell sort (after the third pass) (5%)

(c) Heap sort (after the second pass) (5%)

3. (15%) Given a directed graph G, how to determine if G has cycles?

(a) Please write your pseudo code. (10%)

(b) Please give an application example which needs to apply the cycle detection concept. (5%)

(背面仍有題目,請繼續作答)

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二、Algorithms (50%)

4. (20%) (a) (10%) Is $2^{n+1} = O(2^n)$? (b) (10%) Is $2^{2n} = O(2^n)$?

5. (20%) Solving the recurrence $T(n) = 9T(n/3) + n$ using Θ notation.

6. (10%) Present a linear-time algorithm to find the strongly connected components of a directed graph.