

系所組別： 資訊工程學系

考試科目： 程式設計

考試日期： 0307，節次： 2

※ 考生請注意：本試題 可 不可 使用計算機

Data Structures (50%)

1. (15%) The Fibonacci polynomials are defined by the recurrence relation

$$F_n(X) = X \cdot F_{n-1}(X) + F_{n-2}(X) \text{ where } F_0(X) = 1, F_1(X) = X, \text{ and } n \geq 2.$$

How many memory spaces are actually needed to hold the Fibonacci polynomials F_0, F_1, \dots, F_{100} ?

(a) below 4000 (b) 4000~4500 (c) 4501~5000 (d) 5001~5500 (e) above 5500

2. (10%) Which of the following statements are true.

(a) In a directed graph G , if vertex x has both incoming and outgoing edges, its tree in the DFS forest contains more than one vertex.(b) A d -ary heap is like a binary heap, but non-leaf nodes have d children instead of 2 children. The running time of the efficient implementation of Extract-Max in a d -ary max-heap with n elements is $\Theta(\log_d n)$.(c) A Hamiltonian Path in graph G passes through each node $v \in V$ exactly once. Given a directed acyclic graph $G=(V, E)$, its Hamiltonian path v_1, v_2, \dots, v_n must be a topological ordering of G .(d) In an undirected graph G , if there is a path between two vertices x and y then in the DFS tree of G , either x is a descendant of y or y is a descendant of x .

3. (25%)

(a) An edge, (u, v) , of a connected graph, G , is a bridge iff its deletion from G produces a graph that is no longer connected. Please directly modify the function `bicon` in the following code segment to find the bridges in a graph. (20%)

(b) What is the time complexity of the new function? (5%)

(背面仍有題目,請繼續作答)

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Code segment for Problem 3 of Data structure

```
#define MIN2(x,y) ((x) < (y) ? (x):(y))
short int dfn[MAX_VERTICES];
short int low[MAX_VERTICES];
void bicon(int u, int v)
{
    /* Compute dfn and low, and output the edges of G by their biconnected
    components, v is the parent (if any) of u in the resulting spanning tree. It is assumed
    that all entries of dfn[] have been initialized to -1, num is initially to 0, and the stack is
    initially empty */
    node_pointer ptr;
    int w,x,y;
    dfn[u] = low[u] = num++;
    for (ptr = graph[u]; ptr; ptr = ptr->link) {
        w = ptr->vertex;
        if (v!=w && dfn[w] < dfn[u])
            push(u,w);
        if (dfn[w] < 0) {
            bicon(w,u);
            low[u] = MIN2(low[u],low[w]);
            if (low[w] >= dfn[u])
                printf("New biconnected component:");
            do{
                pop(&x,&y);
                printf("<%d,%d>",x,y);
            } while (!(x == u) && (y == w));
            printf("\n");
        }
        else if (w != v)
            low[u] = MIN2(low[u],dfn[w]);
    }
}
```

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二、 Algorithms (50%)

4. (10%) Solving the recurrence $T(n) = T(n-1) + \frac{1}{n}$ using Θ notation.
5. (20%) Given two sequences $X = \langle x_1, x_2, \dots, x_m \rangle$ and $Y = \langle y_1, y_2, \dots, y_n \rangle$, define $c[i, j]$ to be the length of an LCS (longest common subsequence) of the sequences $X_i = \langle x_1, x_2, \dots, x_i \rangle$ and $Y_j = \langle y_1, y_2, \dots, y_j \rangle$. Write the recursive formula to compute $c[i, j]$.
6. (10%) Prove or disprove: The single-source shortest paths problem can be solved in linear time in directed acyclic graphs.
7. (10%) What is the running time of QUICKSORT when all elements in the input array have the same value (using Θ notation)?