國立臺灣師範大學九十七學年度碩士班考試入學招生試題

軟體基礎 科試題（資訊工程學系用，本試題共 6 頁）

注意：
1.依次序作答，只要標明題號，不必抄題。
2.答案必須寫在答案卷上，否則不予計分。

1. A data sequence NPLDIAFJM is given. The data in the sequence is inserted to an empty binary search tree one by one according to the given input order.

(i) What is the depth of the constructed binary search tree? (單選) (2 分)

    (a) 3

    (b) 4

    (c) 5

    (d) 6

(ii) There are four kinds of tree traversal methods (preorder, inorder, postorder, and level-order traversals) to visit the constructed binary search tree to get different data sequences. Which traversal method(s) get the data sequence whose insertion order will get the same binary search tree with the original one? (複選) (4 分)

    (a) preorder traversal

    (b) inorder traversal

    (c) postorder traversal

    (d) level-order traversal

2. Suppose p is a pointer of node which points to the rear of a circular linked list. Initially, p = null. The following program codes will insert a node pointed by pointer q at the rear of the circular list. Please fill in the blanks. (4 分)

```
if  (IS_EMPTY(p)){
    p = _____<1>_____;
    q->link = p;
    }
else {
    _____<2>_____ =p->link;
    p->link = _____<3>_____;
    p = _____<4>_____;}
}
```

3. Which of the following are true? (5 分) (複選)

A stack is an applicable data structure for :

(a) level-order traversal of a tree

(b) depth-first traversal of a graph

(c) operating system first-in-first-out job scheduler

(d) postfix expression evaluation

(e) LSD radix sort

4. Suppose the number of data for sorting is n, which of the following statements are true? (5 分) (複選)

(a) The average case time complexity of merge sort is $O(n\log n)$.

(b) The worst case time complexity of heap sort is $O(n^2)$.

(c) The worst case time complexity of quick sort is $O(n^2)$.

(d) Quick sort is a stable sort.

(e) In addition to the space requirement for storing the data, the extra space required to perform the heap sort is $O(\log n)$.

5. Given the identifier set $(a_1, a_2, a_3)=(\text{begin, end, if})$.

E_0 contains the identifiers x such that $x < a_1$, and E_i contains the identifiers x such that $a_i < x < a_{i+1}$, $1 \le i < n$.

The frequency to search for each a_i is p_i.

q_i is the frequency that the identifier we are searching for is in E_i.

Suppose $p_1=1$, $p_2=1$, $p_3=3$ and $q_1=2$, $q_2=1$, $q_3=1$, $q_4=3$.

Please construct the optimal binary search tree for identifier set (begin, end, if).

(5 分)

6. If the time complexity of the function doIt() is expressed as $O(n^2)$, please calculate the time complexity of the following program segment in term of it big-O. (5 分)

```
i=1;
for (i<n)
   {doIt();
    i=i*3;}
```

7. There is an undirected graph G. The adjacency matrix of G is shown below. However, some entries in the matrix are missing. It is known that G is a connected graph and vertices 1, 2, and 4 are articulation points. Besides, "013245" is a result of DFS traversal on graph G. Please fill in the missing entries. (5 分)

	0	1	2	3	4	5
0	0	1	0	0	0	0
1	1	0	1	$<a>$	0	0
2	0	1	0	1	1	0
3	0	$<b>$	1	0	$<c>$	0
4	0	0	$<d>$	$<e>$	0	1
5	$<f>$	0	0	0	1	0

8. Heap structure

(a) Please show the formula to get the height of a max-heap with n nodes. (2 分)

(b) Give the following list of numbers: 16, 65, 73, 43, 24, 82, 32, 50 stored in array tree[1], tree[2], ..., tree[8]. Please perform the following procedure to construct a maximum heap, where n is equal to 8. Please show content of the resultant array. (5 分)

```
void adjust(int n)
{ int i, j, k;
    for (i = n/2; i>=1; i--)
      {k = tree[i];
       j=2*i;
       while (j<=n){
           if ((j<n) && (tree[j] < tree[j+1])) j++;
           if (k > tree[j]) break;
           else {
                 tree[j/2] = tree[j];
                 j = j*2;
               }
           }
         tree[j/2] = k;
       }
}
```
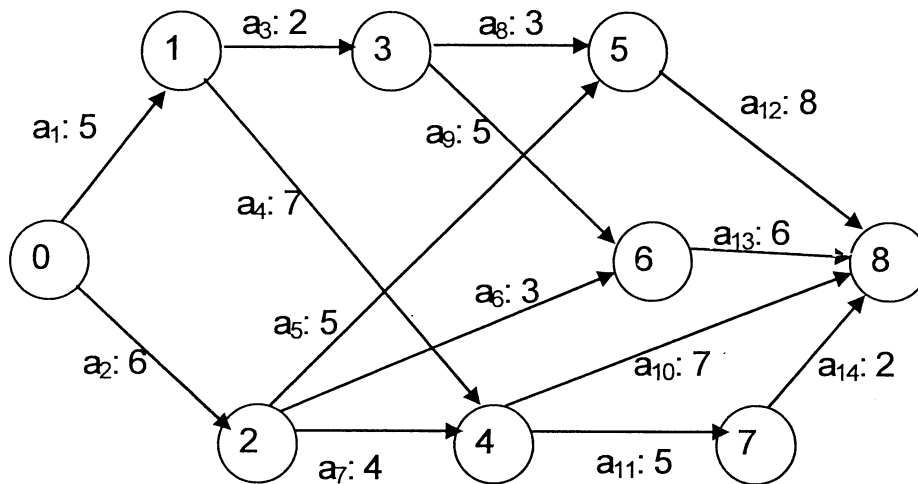
9. For the AOE network shown below, please answer the following questions.

(a) Which activities are critical? (5 分)

(b) Is there a single activity whose speed up would result in a reduction of the project length? If the answer is "yes", please list the activities.(3 分)

10. Suppose that we need to do multiplication operations on two positive integers whose size exceeds the computer's hardware capability of representing integers. If we need to maintain all the significant digits in our results, switching to a floating-point representation would be of no value. In such cases, our only alternative is to use software to represent and manipulate the integers. A straightforward way to represent a large integer is to use an array of integers, in which each array slot stores one digit. We will assume this representation and use the defined data type **large_integer** to mean an array big enough to represent the integers in the application of interest. The following pseudocode is a divide-and-conquer approach for solving the problem of multiplication of large integers.

```
large_integer prod(large_integer u, large_integer v)
{    large_integer x, y, w, z;
     int n, m;
     n = maximum (number of bits in u, number of bits in v)
     if (u == 0 || v == 0)        return 0;
     else     if (n <= 1)         return u × v obtained in the usual way;
     else { m = ⌊n/2⌋;
            x = u divide 2ᵐ;     y = u mod 2ᵐ;
            w = v divide 2ᵐ;     z = v mod 2ᵐ;
            return prod (x,w) × 2²ᵐ + (prod(x,z)+ prod(w,y)) × 2ᵐ + prod(y,z);   }
}
```

(a) For the above algorithm, please write a recurrence equation $T(n)$ for the number of basic operations needed to solve an instance when the input size is n. That is, $n = maximum$ (number of bits in u, number of bits in v). (5 分)

(b) What is the solution to the recurrence equation in (a)? (5 分)

(c) Use the above algorithm to find the product of 0101 (that is, decimal 5) and 1110 (that is, decimal 14). Please show the results, step by step. (10 分)

(d) Please design a non-recursive algorithm with a same time-complexity to solve the same problem. (10 分)

11. Consider the following scheduling problem. Suppose a man has several jobs waiting for his treatments. Each job takes one unit of time to finish and has a deadline and a profit. He can only do one job at anytime. If a job starts before or at its deadline, its profit is obtained. The goal is to schedule the jobs so as to maximize the total profit. But, not all jobs have to be scheduled.

(a) Suppose he has the following jobs, deadlines, and profits. Please derive a schedule that maximizes the total profit. (10 分)

Job	Deadline	Profit
1	2	40
2	4	15
3	3	60
4	2	20
5	3	10
6	1	45
7	1	55

(b) If he has lots of jobs, then it is not easy to derive the best schedule. Please design an efficient algorithm to find a schedule that maximizes the total profit. Please use the example in (a) to describe your algorithm. (10 分)