國立中興大學 112 學年度碩士班招生考試試題

科目： 資料結構與演算法　　系所： 資訊工程學系 甲組

本科目不得使用計算機　　本科目試題共 4 頁

PART 1. Data Structures

A. Multiple Choice (6%)

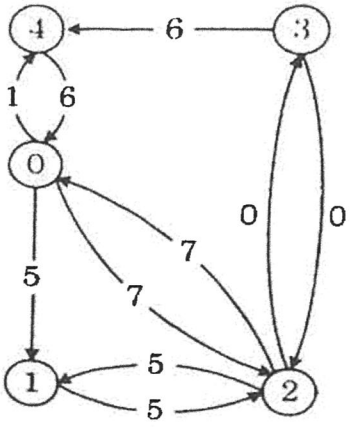
1. We have stored the two-dimensional array *student* in memory. The array is 100 * 4, i.e., 100 rows and 4 columns. Assume the following three conditions for this array. (3%)
   (1) The element student [1][1] is stored in the memory location with address 1000;
   (2) Each element occupies only one memory location;
   (3) The computer uses row-major storage, which means an entire row of an array is stored in memory before the next row.
   What will be address of the element students [5][3]?
   (a) 1013 (b) 1014 (c) 1017 (d) 1018

2. Which is the highest time complexity? (3%)
   (a) $O(n^{100})$
   (b) O(n!)
   (c) $O(n^2 log_2 n)$
   (d) $O(2^n)$

B. Short Answer Questions (44%)

1. A binary search tree is used to locate the number 43. Which of the following probe sequences are possible? (6%)
   (a) 61, 52, 14, 17, 40, 43
   (b) 2, 3, 50, 40, 60, 43
   (c) 10, 65, 31, 48, 37, 43
   (d) 81, 61, 52, 14, 41, 43
   (e) 17, 77, 27, 66, 18, 43

2. The cost of the shortest path from i to j is $A^k[i][j]$, as no vertex has an index greater than k. Consider the following graph. Show the largest value of the non-infinity entries in matrix A^1. (6%)



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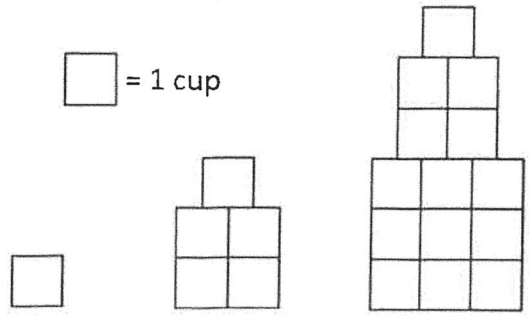
3. Let a and b denote positive integers. Suppose a function Q is defined recursively as follows. Find the value of Q(5861, 7). (5%)

$$Q(a,b) = \begin{cases} 0 & if\ a < b \\ Q(a-b,b)+1 & if\ b \le a \end{cases}$$

4. According to the rules. How many cups he wants to stack?
   - Tower of each layer that is stacked in a square, like the picture.
   - N: Number of layers

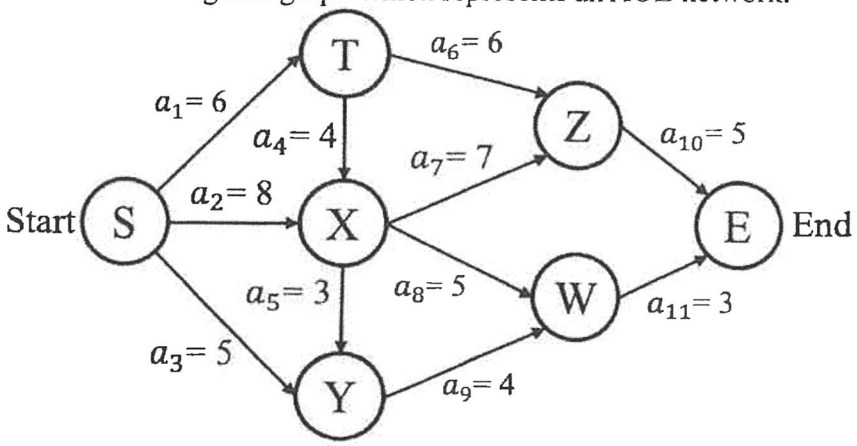
□ = 1 cup

```
int crystal (int N) {
    if (N==1)
        return 1;
    else
        return (1);
}
```



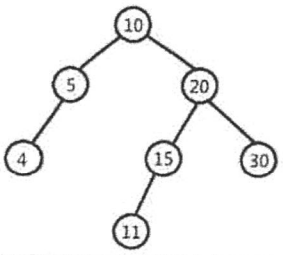
(a) Finish the program (i.e., (1)) using C program in this problem. (5%)
(b) What is the result of crystal (6)? (5%)

5. Given a directed, connected and weighted graph which represents an AOE network.



(a) What is the critical path in this network? (3%)
(b) Compute the earliest time and the latest time of X, Y and W (6%)

6. Consider the binary search tree on the below. If we randomly search **one of the keys present in the binary search tree**, what would be the expected number of comparisons? (round it to the second decimal place, 8%)



　背面有題，請繼續作答。

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PART 2. Algorithms

C. 單選題 (15%)

I. Consider the C code fragment given below. Assuming that m and n point to valid NULL- terminated linked lists, invocation of join will

A. append list m to the end of list n for all inputs.
B. either cause a null pointer dereference or append list m to the end of list n.
C. cause a null pointer dereference for all inputs.
D. append list n to the end of list m for all inputs.

```
typedef struct node {
    int data;
    node* next;
} node;

void join(node* m, node* n) {
    node* p = n;
    while(p->next != NULL) {
        p = p->next;
    }
    p->next = m;
}
```

II. The following C function takes a singly-linked list as input argument. It modifies the list by moving the last element to the front of the list and returns the modified list. Some part of the code is left blank. Choose the correct alternative to replace the blank line.

A. q = NULL; p->next = head; head = p;
B. q->next = NULL; head = p; p->next = head;
C. head = p; p->next = q; q->next = NULL;
D. q->next = NULL; p->next = head; head = p;

```
typedef struct node
{
    int value;
    struct node *next;
} Node;
Node *move_to-front(Node *head)
{
    Node *p, *q;
    if ((head == NULL) || (head -> next == NULL))
        return head;
    q = NULL;
    p = head;
    while (p->next != NULL)
    {
        q=p;
        p=p->next;
    }
    _____

    return head;

}
```

III. The following function computes the maximum value contained in an integer array p[ ] of size n (n >= 1). The missing while loop condition is

A. a != n
B. b != 0
C. b > (a + 1)
D. b != a

```
int max (int *p,int n) {
    int a = 0, b=n-1;

    while (_____) {
        if (p[a]<= p[b]) {a = a+1;}
        else             {b = b-1;}
    }
    return p[a];
}
```

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D. 簡答題(35%)　請於答案卷上作答，否則不予計分。

I. The Knuth-Morris-Pratt string-pattern matching algorithm requires a failure function. Please use the failure function for the following pattern to fill the table. (5%)

Index	0	1	2	3	4	5	6	7	8
Pattern	a	b	a	a	b	a	a	a	a
Failure									

II. You are the program chair of a conference! Part of your job is to assign papers to reviewers. You have 6 papers P1, P2, P3, P4, P5, P6 and 3 reviewers R1, R2, R3. Initially, each reviewer constructs a list of papers he is willing to review as followings: R1 = {P1, P3, P5, P6}, R2 = {P1, P2, P4}, R3 = {P1, P2, P3, P4, P5, P6}. An assignment of papers to reviewers is valid if each paper is assigned to at least 2 distinct reviewers that are willing to review that paper. The maximum number of papers assigned to any one reviewer should not be greater than 4. You would like to maximize the total number of papers which are validly assigned. Please model this problem using a *s-t* flow network G = (V, E)

1. Draw a flow network with capacity labeling. (5%)
2. What is the maximum number of papers that can be validly assigned? (5%)

III. Consider the multiplication of four matrices with dimensions in the following order: 10×11, 11×25, 25×40, 40×2. Find the optimal parenthesization of the above product and the minimum number of scalar multiplications needed. (5%)

IV. Consider the problem of finding a vector $(x_1, x_2, x_3, x_4, x_5)$ satisfying the following constraints such that $x_1 + x_2 + x_3 + x_4 + x_5$ is maximized, where $x_i \leq 0$ for i=1, … ,5. What are the maximum value and the corresponding vector? (5%)

V. Assume P ≠ NP. For each of the following problems, decide whether it is a P-problem, or an NP-hard (or NP-complete) problem, or neither. Please answer 1, if it is a P-problem, answer 2 if it is an NP-hard (or NP-complete) problem, and answer 3 if it is neither 1 nor 2. (10%)

(1) Find a longest simple path between two nodes, where the given graph has positive edge weights.
(2) Find a shortest simple path between two nodes in a directed graph with negative and/or positive edge weights, and containing negative weight cycles.
(3) Find a negative weight directed cycle in a weighted directed graph.
(4) Find a positive weight directed cycle in a weighted directed graph.
(5) Find a largest cycle in a graph, where the edge-weight is 1 for each edge.
(6) Find a smallest cycle in a graph, where the edge-weight is 1 for each edge.
(7) Find a maximum cut in a flow network.
(8) Find a minimum cut in a flow network.
(9) Find a maximum independent set in an interval graph.
(10) The 2-CNF-Satisfiability problem.