考試科目	計算機概論	所別	資訊科學	考試時間	4月18日 星期日 上午第一節

1. (10%)

Consider a disk on PC has the following characteristics

Rotation speed = 7200 revolution/minute

Arm movement time= 1 msec fixed startup time + 0.1 msec for each track crossed (the 1 msec is a constant no matter how far the arm moves)

Number of surfaces = 2 (a single read/write arm holds both read/write heads)

Number of tracks per surface=100

Number of sectors per track=20

Number of characters per sector = 512

(1) How many characters can be stored on a single disk?

(2) The access time to any individual sector of the disk is made up of three components. Please list these three components.

(3) What is the best case disk access time for this disk?

(4) What is the worst case disk access time for this disk?

2. (10%)

Two major internal data structures in the assembler are the Operation Code Table (OPTAB) and the Symbol Table (SYMTAB).

(1) Please list the functional requirements of OPTAB.

(2) Which of the following data structures are beneficial for the OPTAB: (a) sorted array (b) binary search tree (c) AVL tree (d) minimum spanning tree (e) static hashing, (f) dynamic hashing (g) minimum perfect hashing (h) heap (i) graph (j) inverted file? Why?

(3) Please list the functional requirements of SYMTAB.

(4) Which of the following data structures are beneficial for the SYMTAB: (a) sorted array (b) binary search tree (c) AVL tree (d) minimum spanning tree (e) static hashing (f) dynamic hashing (g) minimum perfect hashing (h) heap (i) graph (j) inverted file? Why?

3. (8%)

(1) There are several basic methods of passing parameters to subprograms in programming languages. Please list the basic methods of passing parameters in C Languages?

(2) In C language, a typical statement to output the value of an integer variable xvar is

```
printf("%d", xvar);
```

while that to input a value to an integer variable xvar is

```
scanf("%d", &xvar);
```

Please give the reasons why there exists the difference between the two notations of the variables for I/O statements.

4. (4%)

Given a two-dimension array x[1024, 1024]. The size of each row of this array is design to be the size of a page in main memory. Assume that there is only one frame which is just only one page size in main memory. How many page faults will occur for the following program segment?

```
for (i=0; i<=1023; i++)
    for (j=0; j<=1023; j++)
        x[i, j]=0;
```

5. (10%)

In the relational data model, the *referential integrity constraint* states that the value of the *foreign key* in one relation S must refer to an existing value of the referred *primary key* in the other relation R.

STUDENT	
StudID	Name
001	Grace
003	James
006	Mary

SCORE		
CourseNo	StudentNo	Score
003	001	90
005	001	85
001	003	90
002	006	80

For example, given the above two tables STUDENT and SCORE, the primary key of table Student is the attribute StudID while that of table SCORE is the composition of attributes CourseNo and StudentNo. Moreover, StudentNo is a foreign key of table SCORE which refers to the primary key StudID of table STUDENT. Under referential integrity constraint, each instance of the foreign key StudentNo in table SCORE must match the instance of the primary key StudID of some tuple in table STUDENT. Note that in the relational data model, each table must have a primary key. However, some tables may have no foreign keys.

(1) Given a relational database schema with three tables R, S, T and associated primary keys A, B, C respectively. Table R has a foreign key X which refers to the primary key C of table T while table T has a foreign key Z which refers to the primary key B of table S. Assume that after the construction of the database schema, there is no tuples in these tables. To import tuples from the raw text data to these tables, it is important to consider the importing order of tables for the referential integrity constraint. Please list the order for importing these tables.

(2) Given a relational database schema with n relational tables, the associated primary keys and the foreign keys, please design the data structure and algorithm, under the *referential integrity constraint*, to find a correct order for importing the data to these tables based on a well-known graph algorithm.

6. (8%) 選擇題（每小題 2 分，答錯倒扣 1 分。此大題最低 0 分）

(1) ( ) Which one of the following phases checks the sequence of tokens to see whether it is

syntactically correct according to the rules of the programming language.

(a) lexical analysis

(b) semantic analysis and code generation

(c) parsing

(d) code optimization

(2) ( ) Which one of the following technologies is the most similar to the operation of proxy servers ?

(a) virtual memory

(b) time-sharing

(c) cache memory

(d) pipeline

(3) ( ) Which one of the following protocols support the fast connectionless service.

(a) UDP

(b) TCP

(c) SMTP

(d) ARP

(4) ( ) Given the following program segment, what is the value of the variable svar after execution of this statement?

```
svar = x(4)
int x(n)
{     if (n <=1)
        return 1;
  else
        return(x(n-1)+x(n-2)); };
```

(a) 3

(b) 4

(c) 5

(d) 6

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說明：1. 請書寫必要之解題過程。過程正確但答案錯誤，可能有部分分數。如題目之解答非顯而易見者，僅書寫答案而缺乏必要之過程，亦無法獲得該題之滿分。

2. 可使用中文或英文作答。

7. (10%, 2% for each problem) 選擇題(select a number).

(1) Which of the following items is not true for a binary search tree (BST)?
   (a) It takes constant time, O(1), in finding the minimum or maximum in a BST.
   (b) For any node x in a BST tree, let y denote any element in the left subtree of x and let z denote any element in the right subtree of x, we have $y < x < z$. (Assume that all the elements in the tree are distinct.)
   (c) The insert and delete operations takes O(log n) time for a BST with n nodes.
   (d) The worst case dynamic set operations on a BST take O(n) time.

(2) The worst case performance of quicksort is
   (a) O(n)　(b) O(n log n)　(c) $O(n^2)$　(d) $O(2^n)$

(3) The worst case of insertion operation on a BST takes
   (a) O(log n)　(b) O(n)　(c) O(n log n)　(d) $O(n^2)$

(4) In depth-first-search algorithm, the order that the node is processed is similar to that of
   (a) BFS　(b) inorder traversal　(c) preorder traversal　(d) postorder traversal

(5) The elements in a queue is processed in FIFO fashion, which is similar to
   (a) BFS　(b) DFS　(c) preorder traversal　(d) postorder traversal

8. (14%, 2% for each problem) 是非題(True or False):

(1) Adjacency matrix is good for representing sparse graph.
(2) The minimum spanning tree of a n-node graph has O(log n) edges.
(3) $2^{2n} = O(2^n)$.
(4) Membership test in a linked list requires O(log n) time, in the worst case, for input size n.
(5) Both insert and delete operations of a queue take O(1) time.
(6) A binary tree can be used to represent a tree with more than 2 child nodes of a (parent) node.
(7) A 2-3 tree with height h has at least 2^h-1 leaves and at most 3^h-1 leaves.

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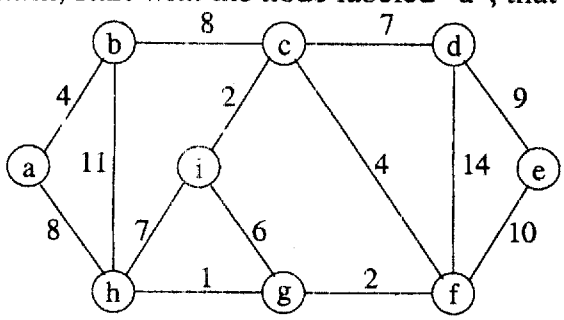
9. (10%)

There are two algorithms, the Kruskal's algorithm and the Prim's algorithm, for finding the Minimum Spanning Tree(MST) of a graph G=(V,E), where V denotes the set of vertices and E denotes the set of edges. These algorithms are given below:

Algorithm Kruskal(G)
//Kruskal's algorithm for constructing a MST
//Input: A weighted connected graph G=(V,E)
//Output: E_T, the set of edges composing a MST of G
Sort E in non-decreasing order of the edge weights
so that $w(e_{i_1}) \le w(e_{i_2}) \le \cdots \le w(e_{i_{|E|}})$
$E_T \leftarrow \varnothing$; $ecounter \leftarrow 0$ //Initialize the set of tree edges and its size
$k \leftarrow 0$ //Initialize the number of processed edges
while $ecounter < |V|-1$
  $k \leftarrow k+1$
  if $E_T \cup \{e_{i_k}\}$ is acyclic
    $E_T \leftarrow E_T \cup \{e_{i_k}\}$; $ecounter \leftarrow ecounter+1$
return E_T

Algorithm Prim(G)
//Prim's algorithm for constructing a MST
//Input: A weighted connected graph G=(V,E)
//Output: E_T, the set of edges composing a MST of G
$V_T \leftarrow \{v_0\}$ //Initialize the set of tree vertices to v_0
$E_T \leftarrow \varnothing$
for $i \leftarrow 1$ **to** $|V|-1$ **do**
  find a minimum - weight edge $e^* = (v^*, u^*)$
    among all the edges (v, u)
    such that v^* is in V_T and u^* is in $V - V_T$
  $V_T \leftarrow V_T \cup \{u^*\}$
  $E_T \leftarrow E_T \cup \{e^*\}$
return E_T

Answer the following questions according to these two algorithms and the diagram below:
(1) (5%) Find the 6th edge added to the MST of the following graph using Kruskal's algorithm.
(2) (5%) Find the 6th edge added to the MST of the following graph using Prim's algorithm.
(If there are two edges with the same edge weight, select the one with "smaller" alphabetical order first. For the Prim's algorithm, start with the node labeled "a", that is, v_0 is set to the "a" node.)



10. (6%)

The recurrence equation, as described below, can be used to analyze the complexity of divide and conquer method.

$$T(n) = a\ T(\frac{n}{b}) + f(n)$$

Answer the following:

(1) (2%) the role of the function f(n),

(2) (2%) the restriction on b, and,

(3) (2%) why we need such a restriction.

11. (10%)

(1) (3%) What is the lower bound of the comparison based sorting algorithms. (Just state the answer.)

(2) (2%) The time complexity of the radix sort can be proved to be O(d (n+k)), for n d-digit numbers in which each digit ranges from 0 to k. Is this result conflict with the result in (1)?

(3) (5%) Justify your answer in (2).