# 國立成功大學

# 112學年度碩士班招生考試試題

編　號：203

系　所：電機資訊學院-資訊聯招

科　目：程式設計

日　期：0206

節　次：第 2 節

備　註：不可使用計算機

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※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

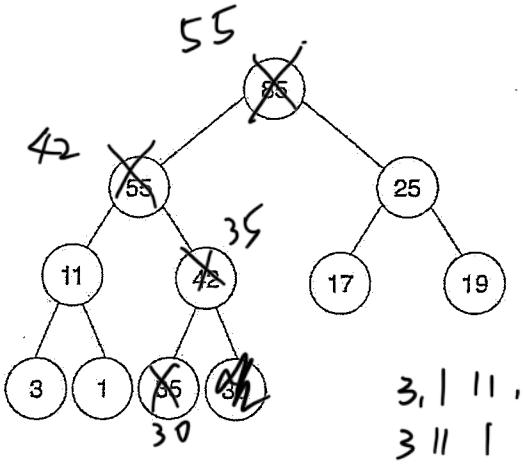
## Part I. 資料結構 (50%)

**注意：資料結構共有 10 考題，每題 5 分，共 50 分。請在答案卷第一頁做表如下，將您的答案整理於該表中。否則，不予計分。**

| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
|---|---|---|---|---|---|---|---|---|---|
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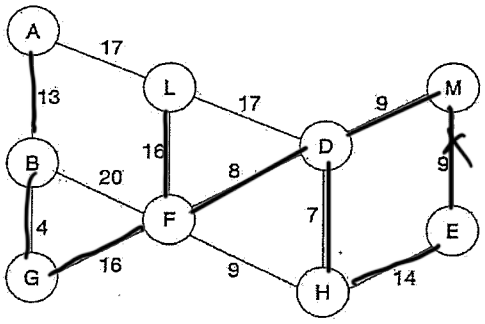
1. [5%] Which of the following statements is (are) correct ?
   (A) Searching a particular data item in a binary search tree with n nodes requires at most $\log_2(n+1)$ comparisons.
   (B) A full binary tree of a given height h has $2^h$-1 nodes. (The root is at height of 1.)
   (C) Represent a binary tree in an one-dimensional array (say, a[]). Assume the root is stored in a[1]. Then, the index of node i's parent is floor(i/2).
   (D) AVL, red-black tree and compressed trie are binary trees.

2. [5%] The following graph is a maximum heap. After removing the maximum element, which of the followings is (are) true ?




   (A) 30 is a leaf node in the resultant heap after removal.
   (B) Suppose we use an array to implement the heap. The 5th element in the array is 30.
   (C) In the post-order traversal, 55 is before 42.
   (D) 25 is at same indexing position in the array for the post-order and in-order traversals.
   (E) The complexity of removal is O(log n), where n is the number of data items in the heap.

3. [5%] Given a graph G as depicted as follows. T is minimum spanning tree (MST) of G. Which of the following descriptions is (are) true?



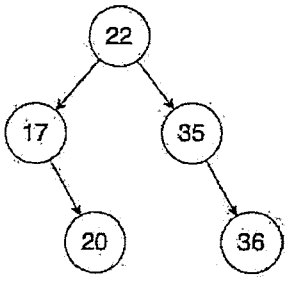

(A) Perform Prim's algorithm to find the MST, starting from node L. The last edge included into the MST is (A, B).

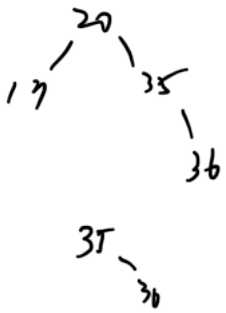
(B) The minimum spanning tree for G is unique.

(C) If let G2 be G by excluding the edge (M, E), then the G2's MST is identical to G's.

(D) Let G3 be G2 removing the edge (B, F). The MSTs' of G2 and G3 are identical.

4. [5%] Given an AVL tree as follows, we perform the operations (A), (B), (C), (D) and (E), independently. Which of these operations would result in the tree to be unbalanced, and shall be restructured?



(A) insert 18

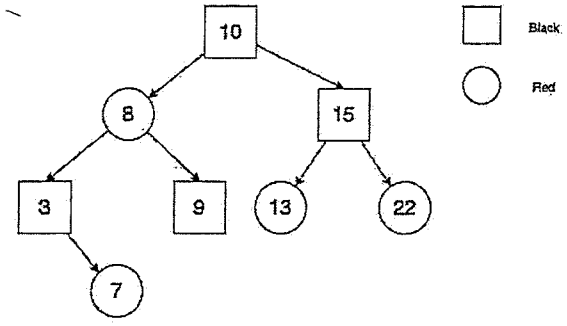
(B) insert 33

(C) insert 38

(D) delete 35

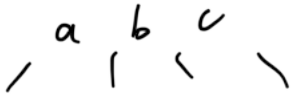
(E) delete 22

5. [5%] Suppose we have a Red-Black tree as shown below. Let us insert 6, 14 and 11 in order. Which of the following statements is (are) correct?




(A) The resultant Red-Black tree contains 6 red nodes.
(B) The color of node of value 8 is black.
(C) The color of node of value 14 is red.
(D) The parent's value of node of value 7 is 3.
(E) The children of node of value 10 are red nodes.

6. [5%] Which of the following statements is (are) correct?
(A) The maximum number of data items stored in an m-way search tree is $m^h$-1, where h is the height of the tree.
✓(B) An 2-3-4 tree is a B-tree of order 5.
✓(C) Any internal node (excluding the root) has at a least ceil(m/2) children in an B-tree of order m.
✓(D) The external nodes on the same level in an B-tree.
✓(E) An Red-Black tree is a binary tree form of an 2-3 tree.





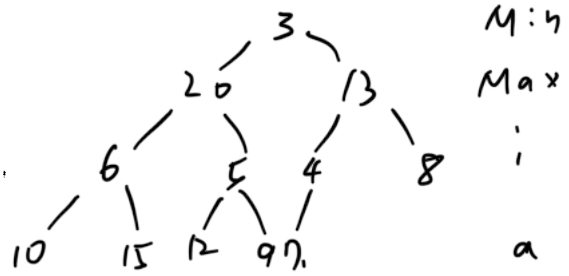

7. [5%] A hash table in size of 10 adopts open addressing with linear probing, where its hash function is defined as h(k)=k%10. The table is initially empty. We insert 6 data items into the table, resulting in the following table. Which of the following choices gives a possible order for inserting the data items to the table?

| | |
|---|---|
| 0 | |
| 1 | |
| 2 | 22 |
| 3 | 43 |
| 4 | 14 |
| 5 | 32 |
| 6 | 26 |
| 7 | 53 |
| 8 | |
| 9 | |

(A) 32, 14, 53, 26, 22, 43
(B) 42, 22, 13, 26, 53, 32
(C) 22, 43, 14, 32, 53, 26
(D) 43, 22, 14, 26, 32, 53 ✓
(E) 14, 43, 22, 32, 26, 53

8. [5%] Consider an Min-Max heap represented as an array [3, 20, 13, 6, 5, 4, 8, 10, 15, 12, 9, 7]. If we exchange any two values X and Y in the array, which of the choices is (are) NOT Min-Max heap(s)?

(A) 5 and 7
✓ (B) 4 and 9
(C) 8 and 9
(D) 13 and 9
(E) 5 and 10



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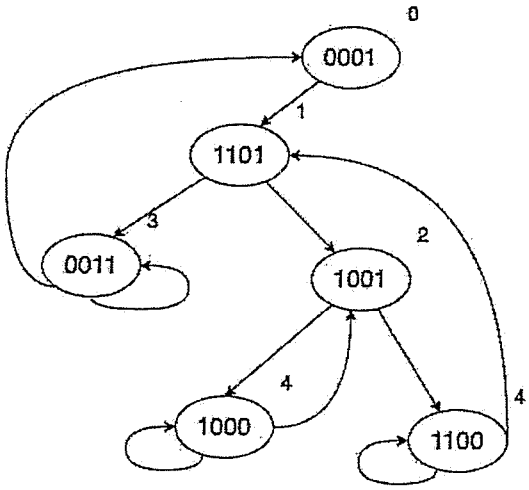
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9. [5%] Suppose we have a Patricia trie as shown below. Let us insert 0110 into and then delete 1100 from the trie. What does node 1101 point to?




(A) 0001
(B) 0110
(C) 0011
(D) 1001
(E) 1000

10. [5%] Please identify which of the following statement(s) is (are) true.
(A) Tries outperform digital search trees in terms of the number of comparison operations performed.
(B) Compared with tries, compressed tries take less storage overheads.
(C) Patricia outperforms compressed tries in terms of storage overheads.
(D) Both Patricia and digital search trees take the identical complexity of storage overheads.
(E) Patricia outperforms digital search trees in terms of the number of comparison operations performed.

## Part II. 演算法 (50%)

11. (10%) Use the master method to give tight asymptotic bounds for the following recursive $T(n) = 27T(n/3) + \Theta(n^3/\lg n)$. (Assume that $T(n)$ is a constant for sufficiently small $n$.)

12. (10%) The following procedure is a bottom-up method for matrix chain order. This procedure assumes that matrix $A_i$ has dimensions $p_{i-1} \times p_i$ for $i = 1, 2, \ldots, n$. Its input is a sequence $p = \langle p_0, p_1, \ldots, p_n \rangle$, where $p.length = n + 1$. Let $m[i, j]$ be the minimum number of scalar multiplications needed to compute the matrix $A_i A_{i+1} \cdots A_j$. The procedure uses an auxiliary table $m[1..n, 1..n]$ for storing the $m[i, j]$ costs and another auxiliary table $s[1..n-1, 2..n]$ that records which index of $k$ achieved the optimal cost in computing $m[i, j]$. Please fill in the empty statements.

```
n = p.length − 1
let m[1..n, 1..n] and s[1..n − 1, 2..n] be new tables
For i = 1 to n
    m[i, i] = 0
For l = 2 to n   // l is the chain length
    For i = 1 to n − l + 1
      j = _____(a) (3%)_____
      m[i, j] = ∞
      For k = i to j − 1
          q = _____(b) (4%)_____
          If q < m[i, j]
              m[i, j] = q
              s[i, j] = _____(c) (3%)_____
```

13. (10%) Illustrate the operation of HEAPSORT on the array $S$=[5, 13, 2, 25, 7, 17, 20, 8, 4]

14. (10%) We are given a sequence $K = \langle k_1, k_2, \ldots, k_n \rangle$ of $n$ distinct keys in sorted order (so that $k_1 < k_2 < \cdots < k_n$), and we wish to build a binary search tree from these keys. For each key $k_i$, we have a probability $p_i$ that a search will be for $k_i$. Some searches may be for values not in $K$, and so we also have $n+1$ "dummy keys" $d_0, d_1, \ldots, d_n$ representing values not in $K$. In particular, $d_0$ represents all values less than $k_1$, $d_n$ represents all values greater than $k_n$, and for $i = 1, 2, \ldots n-1$, the dummy key $d_i$ represents all values between $k_i$ and $k_{i+1}$. For each dummy key $d_i$, we have a probability $q_i$ that a search will correspond to $d_i$. Determine the cost and structure of an optimal binary search tree in the expected cost of search time for a set of $n = 7$ keys with the following probabilities:

| $i$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| $p_i$ | | 0.04 | 0.06 | 0.08 | 0.02 | 0.10 | 0.12 | 0.14 |
| $q_i$ | 0.06 | 0.06 | 0.06 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 |

15. (10%) The following graph is about the maximum flow problem. Each edge is labeled with its capacity. What is the maximum flow from vertex *s* to vertex *t*.

