國立台灣科技大學九十五學年度碩士班招生試題

系所組別： 資訊工程系碩士班

科　　目： 資料結構

總分100分

1. **(15%)** Please answer the following questions.
   1.1 Assume that the addition of a new node to an AVL tree *T* results in a balance factor of -2 for node *X*.
      1.1.1 What was the balance factor of node *X* immediately before the new node is added to *T*?
      1.1.2 If node *X* is the nearest ancestor of the new node whose balance factor becomes ±2, we only need to rebalance the subtree rooted at node *X* in order to rebalance *T*. Why the other parts of *T* need not be rebalanced?
   1.2 What sequence will be produced when an AVL tree is traversed in the order of RVL, where R, V, and L stand for moving right, visiting the node, and moving left, respectively?

2. **(10%)** Suppose that *T* is a complete binary tree with nine elements. Assume the *postorder* traversal of *T* is *A B C D E F G H I*. Give the *inorder* traversal of *T*.

3. **(10%)** The structure of a node is defined as

```
struct node {
        int data;
        struct node *link;
};
```

Suppose that *A* is a circularly linked list of size *n* (i.e. *n* nodes in the list) that was previously used to represent a data structure and *F* is a singly linked list of size *m* which maintains a list of free nodes that can be allocated upon requests. List *A* is no longer used now and you are asked to write a program to free the nodes in *A*, that is, add the nodes in *A* to the singly linked list *F*. How will you design your algorithm? Briefly describe your algorithm in plain text and give the time complexity of your algorithm.

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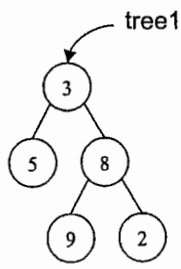
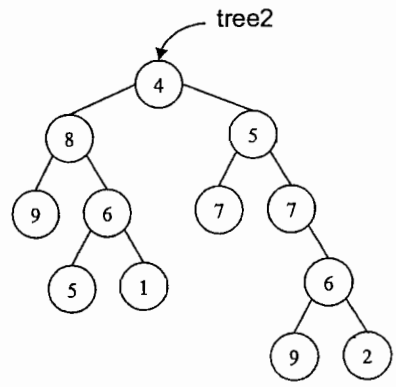
4. **(15%)** A binary tree is defined as follows. Each node of the tree has three fields, data, LeftChild, and RightChild, where LeftChild and RightChild are pointers to the left subtree and the right subtree, respectively. The function Ifno is a recursive function. What are the values returned by Ifno(tree1) and Ifno(tree2) for tree1 and tree2 given below?

```
struct TreeNode {
        char data;
        struct TreeNode *LeftChild;
        struct TreeNode *RightChild;
}
int Ifno(struct TreeNode *root)
{
        int leftn, rightn;

        if (root==NULL)
            return 0;
        else {
            leftn = Ifno(root->LeftChild);
            rightn = Ifno(root->RightChild);
            if ((leftn + rightn) > 0)
                  return leftn+rightn;
            else
                  return 1;
        }
}
```





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5. (15%) Let $A \in R^{7\times 9}$ be matrix give as follows:

$$A = \begin{bmatrix} 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 2 & 0 & 0 & 0 & 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 0 & 3 & 0 & 0 & 0 & 0 & 0 \\ 0 & 4 & 0 & 0 & 0 & 4 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 5 & 0 & 0 & 0 & 0 \\ 6 & 6 & 0 & 0 & 0 & 0 & 0 & 0 & 6 \\ 0 & 0 & 7 & 0 & 0 & 0 & 0 & 7 & 0 \end{bmatrix}.$$

Because there are only very few nonzero elements in the matrix A we use only three integer arrays, val_{row}[], col_ind[] and row_ptr[] to store the matrix given as follows:

val_{row}[]	1	1	1	2	2	3	4	4	5	6	6	6	7	7
col_ind[]	4	6	8	1	7	4	2	6	5	1	2	9	3	8
row_ptr[]	1	4	6	7	9	10	13							

This is called the *Compressed Row Storage* (CRS).

(a) Please design the *Compressed Column Storage* (CCS) and store the matrix A using (CCS).

(b) Describe an algorithm to convert (CRS) into (CCS).

6. (10%) What is your strategy when we need a stable sorting result and only a Quicksort function is given? (hint: The Quicksort in general is not a stable sorting method.)

7. (10%) Please show how to sort n integers in the range 0 to $n^3 - 1$ in $O(n)$ time (hint: by applying radix sort!).

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8. (15%) Please answer the following three questions related to graphs. All three are independent from each other.

(a) In an undirected graph $G = (V, E)$, consider the number of vertices i's to have an odd degree number d_i. Is the number an odd, an even number or both are possible? Why? You may use examples to illustrate your idea if there is a need. (hint: the degree in a vertex is defined as the number of edges linked to this vertex.)

(b) This time, in a directed graph $G = (V, E)$, consider the number of vertices i's to have an odd number of out degree d_i. Is the number an odd, an even number or both are possible? Why? You may use examples to illustrate your idea if there is a need. (hint: the out degree in a vertex is defined as the number of edges leaving this vertex.)

(c) We are given an unknown directed acyclic graph (i.e., no cycle exists in this graph) of six vertices *A*, *B*, *C*, *D*, *E*, *F* as follows. Suppose we know that three outputs of the topological sort of this graph are "*ABCDEF*", "*ACDEBF*", and "*CDBEFA*". What is the biggest possible number of edges can be found in this graph? Please also draw this graph.