

Briefly answer the following question. 10 marks for each

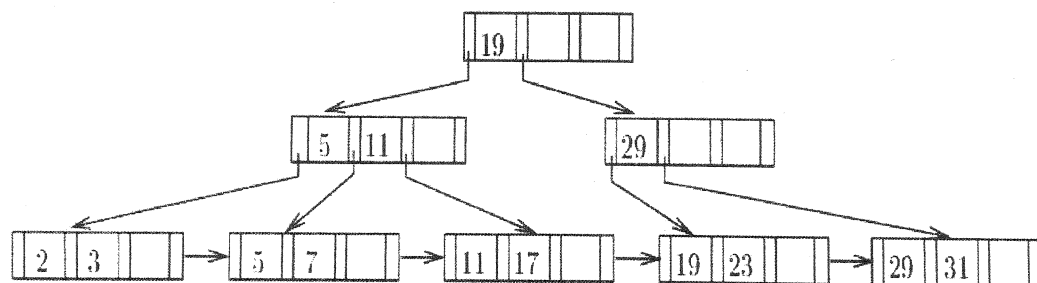
1. The following is type definition nodes in a list.

```
typedef struct listnode *listpointer;
typedef struct listnode {
    integer data;
    listpointer link; };
```

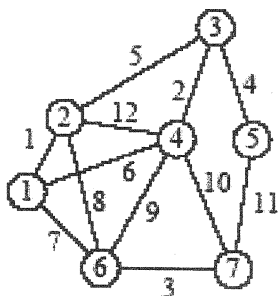
Assume there is a linked list Q, and q is a pointer to the first node in a linked list. Please write a procedure to reverse the order of nodes in the list (10%).

2. Recursion has the mathematical properties outperforming than the iteration. Please write a recursive program to calculate the function, $f(n) = 3^n \times 5^n$ (5%); however, the recursion has its own disadvantages, compared to iteration. Please give at least two of these (5%).

3. Consider the following B-trees whose number of pointers will fit in one node is 2 at most. Please draw the tree, step by step, "after" the following series of operations: a. Insert 9; b. Insert 10; c. Delete 23; d. Delete 19.



4. For the following figure, what is the adjacent matrix for it? (5%) Another way to represent a graph is by its incidence matrix, INC, in which one row is for each vertex and one column is for each edge, respectively. For example, the $INC[i][k] = 1$ if edge j is incident to vertex k . What is the incident matrix for the figure (5%).



5. a. Show that the number of spanning tree in a complete graph with n vertices is at least $2^{n-1}-1$ (5%),
b. Let G be connected, undirected graph on n vertices. Show that G must have at least $n-1$ edges and that all connected, undirected graph with $n-1$ edges are trees (5%).

6. Suppose we start with n sets, each containing one and only one distinct element.
 - a. show that if u unions are performed, then no set contains more than $u+1$ elements;
 - b. show that at most $n-1$ unions can be performed before the number of sets becomes 1.
 - c. Show that if fewer than $\lceil n/2 \rceil$ unions are performed, then at least one set with a single element in it remains.
 - d. Show that if u unions are performed, then at least $\max\{n-2u, 0\}$ singleton sets remain.
7. Obtain an addressing formula for the elements $a[k_0][k_1]\dots[k_{n-1}]$ in an array declared as $a[\text{upper}_0]\dots[\text{upper}_{n-1}]$. Assume a row major representation of the array with w bytes per element and b the address of $a[0][0]\dots[0]$, and are put adjacently, where $\text{upper}_{n-1} > 10$.
8. For the list, $(A(B(E(Z, L), F), C(W), D(H(M), P, O)))$, please (a) draw the corresponding tree for the list; (5%) (b) Please transform the tree to a binary tree and draw this binary tree; (5%)
9. Suppose that the preorder, inorder and postorder traversals of an expression tree are $++WB+*CFE$, $W*B+C*F+E$, and $WB*CF+E++$, respectively. Please draw the expression tree (7%). If only the preorder and inorder traversals exist, how many expression trees match and why comes the answer (3%)
10. For the AOE (activity on edge) network of the following figure, please list the formula to obtain the early start time and late start time for each activity (5%), and which activities are critical and what is the length of the critical path? (5%)

