

(Ten points for each question)

1. The binomial coefficients may be defined by the following recurrence relation, which is the idea of Pascal's triangle. The top of Pascal's triangle is shown in the following figure.

$$\begin{array}{c}
 1 \\
 1 \ 1 \\
 1 \ 2 \ 1 \\
 1 \ 3 \ 3 \ 1 \\
 1 \ 4 \ 6 \ 4 \ 1 \\
 1 \ 5 \ 10 \ 10 \ 5 \ 1 \\
 1 \ 6 \ 15 \ 20 \ 15 \ 6 \ 1 \\
 1 \ 7 \ 21 \ 35 \ 35 \ 21 \ 7 \ 1 \\
 1 \ 8 \ 28 \ 56 \ 70 \ 56 \ 28 \ 8 \ 1 \\
 1 \ 9 \ 36 \ 84 \ 126 \ 126 \ 84 \ 36 \ 9 \ 1
 \end{array}$$

$$C(n, 0) = 1 \quad \text{and} \quad C(n, n) = 1 \quad \text{for } n \geq 0$$

$$C(n, k) = C(n-1, k) + C(n-1, k-1) \quad \text{for } n > k > 0$$

Please draw the recursion tree for calculating $C(6, 3)$.

2. Apply mergesort to the following list of 16 names. Please describe step by step in details. Scott Jenny Mary Roy Kim Julie Ann John Amy Rick Jim Kay Tina Mark Kent Bill.
3. Translate each of the following expressions from prefix form into postfix form.
- (a) $\&\& < a \ b \ || \ == \ + \ a \ b \ c \ > \ a \ 0$
- (b) $/ \ + \ a \ b \ ! \ n$
4. What is the purpose of the big-O notation?
5. Insert the keys $f, g, h, i, j, k, l, m, n, o, p$ into an initially empty red-black tree.
6. Prove that the number of (single or double) rotations done in deleting a key from an AVL tree cannot exceed half the height of the tree.
7. What is the index function for a two-dimensional rectangular array with bounds $(0..m-1, 0..n-1)$.

8. Compare the advantage and disadvantage of linked lists and contiguous lists.
9. What extreme case requires special treatment in writing the subprograms that process linked queues? Why?
10. Explain and describe the procedure of binary search.