

1. (10%) Please analyze the worst case time complexity (in terms of $O()$) of the following program.

```
int BinarySearch(int *a, int x, int left, int right)
{
    if (left <= right) {
        int middle = (left + right) / 2;
        switch (compare(x, a[middle])) {
            case '>': return BinarySearch(a, x, middle + 1, right);
            case '<': return BinarySearch(a, x, left, middle - 1);
            case '=': return middle; }
        return -1;
    }
}
```

2. (15%) If input expression is in postfix format, please write the pseudo code to calculate the result.
3. (10%) Write the merge sort algorithm. Use an example to explain the idea of merge sort.
4. (6%) (a) What is a max heap?
(12%) (b) Please write a program for data insertion into a max heap. Moreover, "analyze" the time complexity (in terms of $O()$) of your program.
(15%) (d) Write a program to construct a max heap from an array, moreover, the time complexity of your program should not exceed $O(n)$ (You should justify your answer).
5. (6%) (a) What is the minimal spanning tree?
(6%) (b) Prim's and Kruskal's algorithms are two ways to get the minimal spanning tree. What are the time complexities of these two algorithms. (Let n and e denote the number of vertex and number of edge respectively.)
(10%) (c) If in graph G , there are n vertices and $n^{1.99}$ edges. Which algorithm will you select to get the minimal spanning tree of G ? Why?
6. (10%) What is hash? How to deal with the case that if collision occurs when hashing a data item into a hash table (at least list two kinds of method).