

※ 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。

一、簡答題：

1. Please analyze and obtain the time complexity (in terms of the "Big -Oh" notation) of the function magSq specified below. (6%)

```
void magSq (int n)
{
    const int MaxSize = 51;
    int square[MaxSize][MaxSize], k, l;

    if ((n > (MaxSize)) || (n < 1)) {cerr<< "Error!..n out of range" << endl; return;}
    else if (!(n%2)) {cerr<< "Error!..n is even" << endl; return;}

    for (int i = 0; i < n; i++)
        for (int j = 0; j < n; j++)
            square[i][j] = 0;
    square[0][(n-1)/2] = 1;

    int key = 2; i = 0; int j = (n-1)/2;
    while (key <= n * n) {
        if(i-1<0) k = n-1; else k = i-1;
        if(j-1<0) l = n-1; else l = j-1;
        if(square[k][l]) i = (i+1)%n;
        else {
            i = k;
            j = l;
        }
        square[i][j] = key;
        key++;
    } //end of while

    for (i = 0; i < n; i++){
        for (j = 0; j < n; j++)
            cout << square[i][j] << " ";
        cout << endl;
    }
}
```

2. Use any program language you prefer to develop a function (using $O(n)$ space) that merges two sorted lists. (8%)

3. Assume that you are a logistics manager of a curtain manufacturing company that produces various kinds of curtain. Your task now is to ship your products from the factory to a warehouse for storage by a container car that carries a container with a maximum size of space M (in cubic meter) and a maximum carrying capacity K (in kilogram). There are n kinds of curtain with sizes (when being folded), weights, and values as $(S_1, W_1, V_1), (S_2, W_2, V_2), \dots, (S_n, W_n, V_n)$ in your factory. Assume that the size of a curtain is proportional to its weight in a 1:3 ratio, and M is greater than K . Additionally, all the curtains can be folded into various shapes without changing their size, and thus you can always fit a curtain (regardless of its shape) into a particular space in the container as long the space is equal to or larger than the size of the curtain. Design and describe, in plain language, an algorithm to find the highest value of products that you can ship out using the indicated containers. (8%)

4. Briefly describe the key criteria for evaluating the quality of an algorithm. (8%)

二、 填充題 (20%)

1. The data structure of _____ is the most suitable for determining palindrome, which refers to a word, phrase, number, or other sequence of characters which reads the same backward or forward (e.g., Amor versus Roma).
2. Regarding the issue of binary tree traversal, _____ requires a queue instead of a stack.
3. Balanced search trees, such as AVL, 2-3-4, and red-black trees, allow one to perform operations (e.g., search, insert, delete, and split) in _____ worst-case time per operation.
4. _____ is a simple sorting algorithm that repeatedly compares each pair of adjacent items in a list to be sorted and swaps them if they are in the wrong order.

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三、Let the data structure for mathematical operations be stacks, and let symbols '^' and '*' represent the operations of exponent and multiplication, respectively.

1. (5%) Give the postfix expression for formula " $a + b * c + (d * e + f) * g$ ".
2. (5%) When $s = 4$, $t = 12$, $u = 3$, $v = 2$, $w = 12$, $x = 8$, and $y = 7$, give the result of postfix expression " $s t u + v ^ * w x + / y +$ ".

四、Consider data structure heaps.

1. (4%) Draw a 4-level tree that is a heap, and justify your answer.
2. (6%) State the two basic heap operations and analyze their time complexity.

五、Consider the Insertion Sort and Merge Sort algorithms for ranking numbers.

1. (5%) From the viewpoint of required storage space, which algorithm should be used and why?
2. (5%) From the viewpoint of computational efficiency, which algorithm should be chosen and why?
3. (5%) From the viewpoint of implementation, which algorithm should be adopted and why?

六、Data can be stored as the following three types of files.

Unordered file: Records are placed on disk in no particular order.

Sorted file: Records are ordered by the value of a specific field.

Hash file: Records are placed on disk according to the value of a specific field transformed by a hash function.

1. (5%) Rank the efficiency of the three types of files for inserting a record, and justify your answer.
2. (5%) Rank the efficiency of the three types of files for updating a record, and justify your answer.
3. (5%) Rank the efficiency of the three types of files for deleting a record, and justify your answer.