

Exam : Data Structures and Algorithms 3 (DSA 3)**Duration: 2h - Documents: not allowed****Academic year : 2025 / 2026****Date : 17/01/2026 (10 : 30 – 12 : 00)****Level : L2 Semester : 5**

First Name		Last Name		Group	
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Exercise No.	1	2	3	4	5	6	Total
Marks Obtained							

Exercise 1: (1.5 Points / 10 Minutes)Write the values of the **int** variables when the following program ends.

#include <stdio.h>

void main() {

int a[] = {0, 1, 4, 9, 16};

int *p, *q;

int i, j, k, l, m, n;

q = &a[4];

p = q - 4;

i = *q;

j = *p++;

k = *--q;

l = p[1];

m = *(q-2);

n = q - p;

}

Answer**i** =**j** =**k** =**l** =**m** =**n** =**Exercise 2: (5 Points / 30 Minutes)**

Q1) Prove that $T(n) = n^2 + \log(n^2)$ is $O(n^2)$ using the formal definition of the Big-Oh notation. **Hint:** Find a constant c and threshold n_0 such that $T(n) \leq cn^2$ for $n \geq n_0$.

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Q2) Calculate the complexity of the following sources fragments; briefly justify your answer:

Pieces of code	Complexity
<pre>int sum = 0; for(int i = n*n; i >= 1; i /= 2) sum++;</pre>	
<pre>for(int i = 1; i < size; i++){ current = arr[i]; for(j = i; j>0 && arr[j-1]>current; j--){ arr[j] = arr[j-1]; } arr[j] = current; }</pre>	
<pre>int sum = 0; for (int i = 0; i < n/2; i++){ for (int j = 0; j < n; j++) sum++; for (int j = 1; j < n * n; j++) for(int k = 1; k < 2026; k++) sum++; }</pre>	
<pre>int func(int n){ for (int i = 0; i < n; i++) // some operations if (n <= 0) return 1; else return 1 + func(n-1) + func(n-1); }</pre>	
<pre>int count = 0; for (int i = n; i > 0; i /= 2) for (int j = 0; j < i; j++) count++;</pre>	

Q3) You must find **1000** most expensive items from an unsorted price list containing **10^7** different items. Two schemes of solution are as follows.

- **Scheme A:** repeat **1000 times** the sequential search (with the linear complexity **$O(n)$**).
- **Scheme B:** convert the list into an array (the same complexity **$O(n)$** as for search), then sort the array (complexity **$O(n \log n)$**) and fetch **1000** top items.

Which scheme would you prefer assuming that searching for **100 items** in the unsorted list takes **0.1 millisecond (ms)** and sorting of **100 items** also takes **0.1 ms**? **Time for fetching data should not be taken into account.**

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Exercise 3: (5 Points / 25 Minutes)

The stooge sort is a recursive sorting algorithm that can be written quite simply:

```
void stooge_sort(int Tab[], int start, int end) {
    if (Tab[start] > Tab[end]) {
        swap(Tab[start], Tab[end]);
    }
    if (end - start + 1 > 2) {
        int t = (end - start + 1) / 3;
        stooge_sort(Tab, start, end - t);
        stooge_sort(Tab, start + t, end);
        stooge_sort(Tab, start, end - t);
    }
}
```

Q1) Run the algorithm for `stooge_sort([6, 7, 0, 5], 0, 3)`. During the execution, you must rewrite the contents of the array **Tab** each time values are swapped.

For each new recursive call, you must indicate the values of the **start** and **end** indices.

Call <code>stooge_sort(Tab, start, end)</code>	Tab are swapped
<code>stooge_sort([6, 7, 0, 5], 0, 3)</code>	<code>[5, 7, 0, 6]</code>
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Q2) Give the recurrence equation for the number of recursive calls performed by `stooge_sort(Tab, 0, n - 1)`, where **n** is the number of elements in **Tab**.

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Q3) Deduce the asymptotic complexity of sorting from the recurrence equation.

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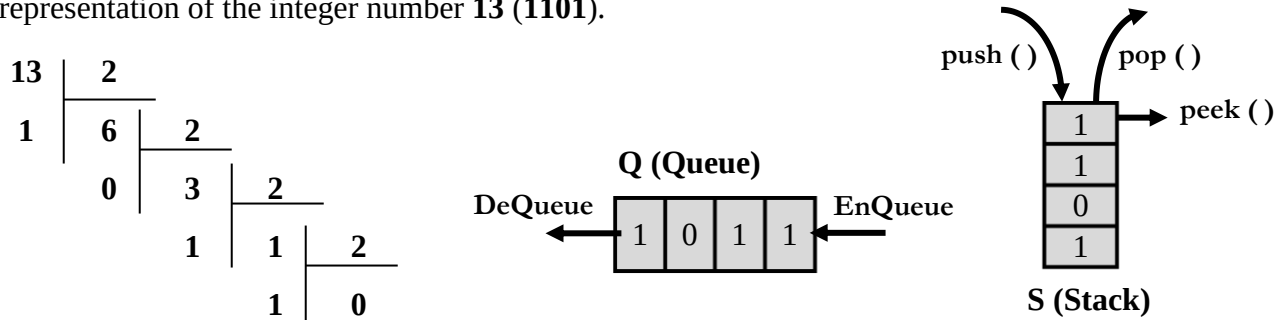
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Q4) What should we think about the complexity of this sorting method compared to Bubble sort and Quick sort?

In the example below, we have a **queue** Q and a **stack** S, each containing the binary representation of the integer number 13 (1101).

[illegible]

Q2) Write the function `binary(x, Q)` which receives a decimal number `x` and creates a queue `Q` containing its binary representation.

[illegible]

Q1) Find the corresponding binary tree T' .

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Q2) In the binary tree T' , write the pre-order, in-order and post-order traversals of each one.

Pre-order	
In-order	
Post-order	

Q3) Is the T' a binary search tree? Why?

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A node in a binary tree is defined as follows:

```

struct BTreeNode {
    int data;
    BTreeNode *left;
    BTreeNode *right;
};

typedef BTreeNode *BTREE;
    
```

