

Question - 1

hashCode, equals, compareTo

SCORE: 5 points

Please choose the correct statements:

- ☒ If `x.equals(y)` is true, then `x.hashCode() == y.hashCode()` must be true
- ☐ If `x.hashCode() == y.hashCode()` is true, then `x.equals(y)` must be true
- ☒ If `x.equals(y)` is true, then `x.compareTo(y) == 0`
- ☐ If `x.compareTo(y) == 0`, then `x.equals(y) == true`

Question - 2

Generalized Reduction

SCORE: 5 points

Based on recursive styles, we could have 2 classes of algorithms: Head-recursion and Tail-recursion.

Please select all head-recursive style sorting algorithms from the following algorithms:

- ☐ Selection Sort
- ☒ Merge Sort
- ☒ Insertion Sort
- ☐ Quick Sort

Question - 3

Analysis of Algorithm

SCORE: 5 points

Approximately how many array accesses have the following code conducted as a function of input size N ?

(Denoted by Tilde Notation)

```
int count = 0;
for (int i = 0; i < N; i++) {
    for (int j = i+1; j < N; j++) {
        if (a[i] + a[j] == 0) {
            count++;
        }
    }
}
```

- ☐ $\sim N$
- ☐ $\sim N*(N - 1)$

- ☐ $\sim \frac{1}{2} N^2$
- ☒ $\sim N^2$

Question - 4

Time Complexity

SCORE: 5 points

What is the time complexity of the following function *fun()*?

Assume that *log(x)* returns log value in base 2.

```
void fun()
{
    int i, j;
    for (i=1; i<=n; i++) {
        for (j=1; j<=log(i); j++) {
            printf("Time Complexity");
        }
    }
}
```

- ☐ $\sim n \ln(n)$
- ☐ $\sim \ln(n)$
- ☐ $\sim \log(n)$
- ☒ $\sim n \log(n)$

Question - 5

Binary Search

SCORE: 20 points

Given a target integer T and an integer array A sorted **in descending order**, find the index i such that $A[i] == T$ or return -1 if there is no such index.

Assumptions

- There can be duplicate elements in the array, and you can return any of the indices i such that $A[i] == T$.

Examples

- $A = \{5, 4, 3, 2, 1\}$, $T = 3$, return 2
- $A = \{5, 4, 3, 2, 1\}$, $T = 6$, return -1
- $A = \{4, 3, 2, 2, 2, 1\}$, $T = 2$, return 2 or 3 or 4

Corner Cases

- What if A is null or A is of zero length? We should return -1 in this case.