University of May 8, 1945 - Guelma
Faculty of Mathematics and Computer Science
Department of Computer Science
2nd Year Engineering - Computer Science
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Exam: Algorithms and Data Structures (Duration: 2 hours)

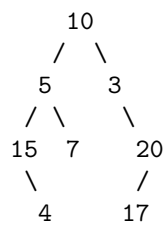
Questions: (6 pts)

Choose the correct answer (only one):

1. The time complexity of O(n^2) means that:
   A. The algorithm performs a number of operations proportional to the square of the input size.
   B. The algorithm performs a number of operations proportional to the input size.
   C. The algorithm performs a constant number of operations independent of the input size.
2. In a tree of height `h`, the maximum number of nodes is:
   B. 2^h - 1.
   A. 2^h.
   C. 2^h + 1.
3. The bubble sort algorithm has a time complexity of:
   A. O(n).
   B. O(n log n).
   C. O(n^2).
4. Among the following sorting algorithms, which one has a space complexity of O(n)?
   A. Insertion sort.
   B. Selection sort.
   C. Merge sort.
5. In a tree, we call a **leaf** a node that:
   A. Has a null value.
   B. Is not connected to the root.
   C. Has no children.
6. To perform a search in a sorted array, the algorithm with the lowest time complexity is:
   A. Linear search.
   B. Binary search.
   C. Manual search.

Exercise 1: (3 pts)

Consider the following binary tree:



1. Give the inorder traversal of the tree.
2. Is the tree a binary search tree? Justify.
3. Find two nodes to swap so that the tree becomes a binary search tree.
4. Give the inorder traversal of the tree after the swap.

Exercise 2: (6 pts)

The symmetric difference of two sets A and B is the set of elements that belong exclusively to A or B, but not to both. Write a function **symmetricDifference** that takes as input two sorted integer arrays A and B and returns a sorted array containing the elements of the symmetric difference of A and B.

- **Assumptions**:
  - The arrays **A** and **B** are already sorted and contain no duplicates.
  - The array **C** is created outside the function with sufficient size to hold the elements of the symmetric difference.
- **Constraint**: The function must have linear time complexity (O(na + nb)).
- **Hint**: You can take inspiration from the merge function used in the merge sort algorithm.
- You are free to write your code in any programming language of your choice. However, you are not allowed to use predefined functions in high-level languages.

Exercise 3 - MI: (5 pts)

The following function is supposed to delete the minimum element from a binary search tree. However, it contains some errors.

```
typedef struct Node* Tree;
typedef struct Node {
    int data;
    Tree *left, *right;
};

Tree deleteMin(Tree root) {
    if (root == NULL) return 0;
    if (root->left == NULL) {
        free(root);
        return root->right;
    } else {
        root->left = deleteNode(root);
    }
    return root;
}
```

- Identify, explain, and correct the errors in the `deleteMin` function.