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| IT3312E Data structures and Algorithms  Final Exam – 90 minutes |  |

**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Student ID:\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Question 1 [10 points]**: Find the best answer for the following multiple choice questions.

1. Which of the following is/are an example(s) for a postfix expression?  
   a) a\*b(c+d) b) abc\*+de c) +ab d) a+b-c
2. The number of elements in the adjacency matrix of a graph having 7 vertices is  
   a) 7 b) 14 c) 36 d) 49 e) None of them

**Question 2 [15 points]**:

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| **a.** Represent the tree in Figure 1. by using Left-most child, right-sibling representation  **b.** List the nodes on the tree in post-order  **Question 3 [5 points]:** Give one advantage of a Linked List, as compared to an array  **Question 4 [20 points]**: Using the function BUILD-MAX-HEAP in heap sort to create a max-heap for the array:  14, 11, 13, 12, 26, 19, 20, 24, 18, 27 | Figure 1. |

**Question 5 [30 points]:**

1. **Binary search [10 points]**: Given an array ***A*** consisting of 17 integer numbers that are sorted in ascending order:

16, 19, 25, 30, 40, 45, 78, 90, 110, 140, 170, 200, 205, 210, 290, 300, 305

We want to determine whether the ***target*** = 211 is appeared in the array ***A*** by using the binary search function int binarySearch(int low, int high, int A[], int target).

Therefore, the first call is binarySearch(0, 16, A, 211);

How many times this function are called in total, and list all the remaining calls.

1. **Binary search tree [10 points]**: Draw the binary search tree that results from inserting the following data values in the order given: 42, 17, 89, 53, 72, 91, 3, 88
2. **[5 points]** List the nodes on the tree obtained in the question b) above in pre-order and breadth-first order
3. **[5 points]** Given the binary search tree obtained in the question b) above, carry out the following operations in sequence: add 5, delete 53, delete 89.