CSCI36200: midterm exam – October 11, 2023 *(Duration: 30 mins)* **Student name:**

Books, notes, laptops, tablets, smartphones are not allowed. **Each question is for 8 points (out of 100)**

1. Consider a sequence of *n* numbers, $A = \{a_1, a_2, \ldots, a_n\}$. Which statement is correct? *(circle one)*
   a. Linear search is to search for the desired element $a_i \in A$, where A consists of linearly increasing or decreasing numbers
   b. Linear search is to search for the desired element $a_i \in A$, where A consists of numbers linearly distributed in the considered domain (e.g. real or integer)
   c. Binary search is to search for the location *i* of the element $a_i \in A$, where A is a binary sequence
   d. **Binary search is to search for the desired element $a_i \in A$, by recursively splitting a sequence in two sub-sequences**

2. Which of the following statements is <u>not</u> correct? *(circle one)*
   a. Both iteration and recursion involve repetition
   b. Iteration and recursion each involve a termination test
   c. Iteration and recursion can occur infinitely
   d. **Recursion is the formal term for describing iteration**

3. What are the benefits of using linked lists compared to arrays? *(circle one)*
   a. They are easier to implement
   b. They can be used in more ways than the arrays
   c. They reduce the complexity of `insert', 'remove', and `search'
   d. **They provide better trade-off between time complexity and memory requirements**

4. The operation `remove' in a singly linked list is executed in *(circle one)*
   a. linear time
   b. **constant time**
   c. quadratic time
   d. none of the above

5. The procedure of finding and removing an element from a singly linked list can be executed in *(circle one)*
   a. **linear time**
   b. constant time
   c. quadratic time
   d. none of the above

6. The node class in a doubly linked list contains *(circle one)*
   a. The data and the location index
   b. Location index and pointers to previous and next data locations
   c. **The data, pointers to the previous and next nodes, appropriate constructors**
   d. Pointers to the data locations in an array

7. Lines 1-4 *(circle one)*
   a. insert element *x* in a binary search tree
   b. delete a leaf node *x* from a binary search tree
   c. **insert element *x* in a linked list**
   d. search for element *x*, by traversing nodes in a linked list

```
1  x.next = L.nil.next
2  L.nil.next.prev = x
3  L.nil.next = x
4  x.prev = L.nil
```

8. A perfect binary tree is a binary tree where each level has the maximum number of nodes. *(circle one)*
   a. The number of nodes at depth *d* in a perfect binary tree is 2^d
   b. A perfect binary tree of height *h* has 2^{h+1}-1 nodes
   c. The number of leaf nodes in a perfect binary tree of height *h* is 2^h
   d. **All of the above**

9. In a binary search tree, *(circle one)*
   a. for each non-leaf node, the keys in its right subtree are greater than the node's key
   b. searching for a key is O(logN)
   c. searching for the minimum takes constant time
   d. **both a and b**

10. In a binary search tree *T*, lines 1-12 do *(circle one)*
    a. inserting a node *z*
    b. **deleting a node *z***
    c. finds the minimum *z*
    d. replaces the subtree rooted at *z* with another subtree

```
1  if z.left == NIL
2      TRANSPLANT(T, z, z.right)
3  elseif z.right == NIL
4      TRANSPLANT(T, z, z.left)
5  else y = TREE-MINIMUM(z.right)
6      if y.p ≠ z
7          TRANSPLANT(T, y, y.right)
8          y.right = z.right
9          y.right.p = y
10     TRANSPLANT(T, z, y)
11     y.left = z.left
12     y.left.p = y
```

11. Which of the following statements is correct? *(circle one)*
    a. **An AVL tree is a binary search tree**
    b. An AVL tree is used for linear search
    c. Balance factors in an AVL tree indicate the number of subtrees rooted at each node
    d. None of the above

12. Stack is a structure that implements dynamic sets, where elements are removed in pre-determined order (circle all that apply)
    a. It is based on the `first in-first out' principle
    b. **It is often used for `back-tracking' in combinatorial problems**
    c. **It reduces the complexity to O(logN) (usually from `brute force' implementations of quadratic complexity)**
    d. **It can be implemented with either an array or a linked list**

13. The implementation of a queue (circle all that apply),
    a. Is more efficient using an array, since it is the simplest structure
    b. **Is more efficient using a linked list, since allocate memory `dynamically' (for each insertion) and not in advance**
    c. **With an array allows for the index of the *head* to be greater than the index of the *tail***
    d. None of the above