**Midterm-II**      **Comp Sci 2C03** - *Data structures and Algorithms*      *Winter 2021*

Name _____ Student No._____

- For your exam you are ONLY allowed to refer to the lecture notes, text book, tutorials and assignments.

- Surfing the internet for ideas and answers is not allowed.

- Clearly write your full name and student number on each sheet.

**Time allotted: 2 hours**                                    **Total Marks: 33**

# Multiple choice questions [6 marks]

Circle your answer. Each question has just one correct answer. Therefore multiple selections will not get a mark.

1. Suppose you have the following sorted list [1, 5, 8, 11, 19, 21, 25, 30, 33] and are using the binary search algorithm given on slide #11 in C3P1.pdf. Give the sequences of elements examined to find the key 5.

    (a) 19, 8, 5
    (b) 19, 5
    (c) 19, 25, 5
    (d) 19, 1, 5

2. Given the keys C O M P U T E, which of the below sequence of keys would produce the best-case binary search tree, when inserted into an initially empty BST.

    (a) C E M O P T U
    (b) U T P O M E C
    (c) O E T C M U P
    (d) O E P T M C U

3. Which of the trees given in Figure 1 is NOT a left leaning red-black tree (LLRBT) generated by the insert operation for LLRBT?
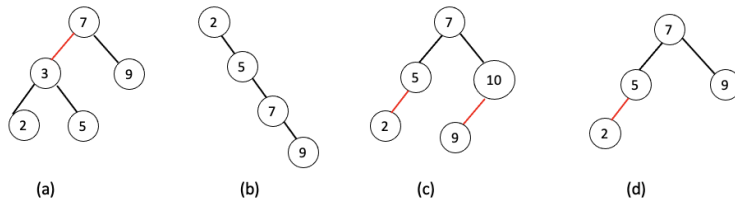
    (a) a
    (b) b
    (c) c

Figure 1: Trees for multiple choice Question 3.

(d) d

4. A search or an insertion in a B-tree of order 10 with 81 keys requires at least 2 probes.

    (a) True
    (b) False

5. Which of the below scenario leads to expected constant running time for a random search hit in a hash table?

    a. All keys hash to the same index.
    b. All keys hash to different indices.
    c. All keys hash to an even-numbered index.
    d. None of the above.

6. How many strongly connected components does a directed acyclic graph (DAG) over $V$ vertices have?

    a. $V - 1$
    b. $0$
    c. $V$
    d. $V/2$

# Provide answers to the 5 descriptive questions below

1. Consider the below BST.
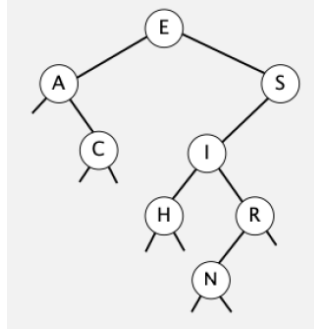


    a. Give the paths followed by the minimum and maximum operations, respectively. [2 marks]

    b. Give the path followed by the Floor(J) and Ceiling(B) operations, respectively. [2 marks]

    c. Draw the resulting tree after deleting the key $E$ from the tree. [2 marks]

2. Draw the (i) 2-3 tree and (ii) left leaning red-black tree that results when you insert the keys **A L G O R I T** in that order into an initially empty tree. Your solution must contain the trees obtained after every insertion. [6 marks]

3. Illustrate the sequence of probing and filling a Hash Table (an array) of size $m = 13$ with the following keys `<26, 52, 61, 68, 91>` using double hashing with $h_1(k) = k$ and $h_2(k) = 1 + (k \mod (m - 1))$. [5 marks]

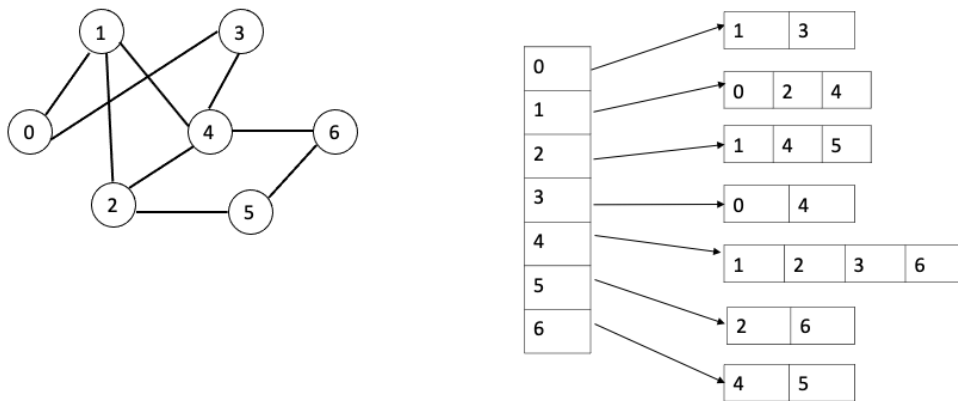4. Draw the output tree for the undirected graph given in Figure 2 when



Figure 2: Graph for and the adjacency list for Question 4

3

a. DFS is called on the source vertex 0. [3 marks]

b. BFS is called on the source vertex 0. [3 marks]

5. Let $G$ be the graph shown in Figure 3. Answer the below questions

a. Give the topological sort of $G$. [3 marks]

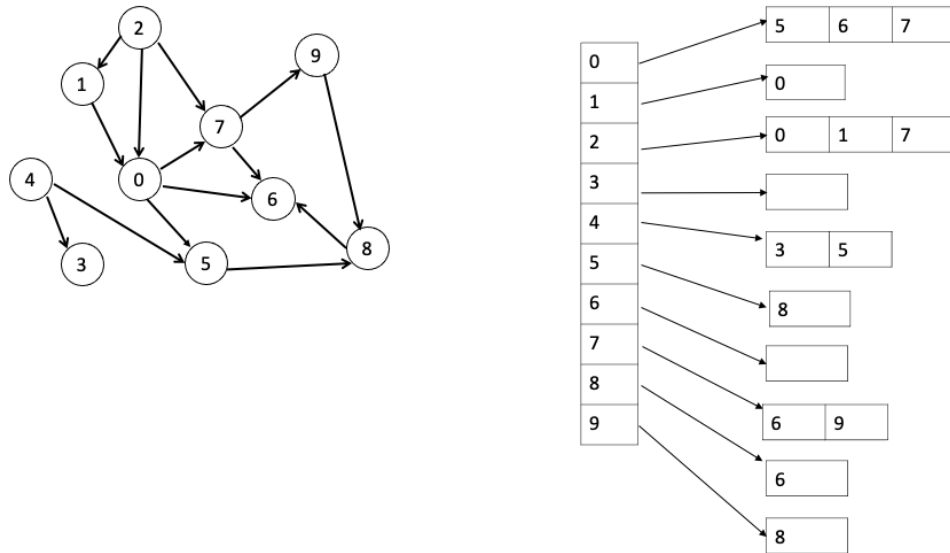b. What is the reverse postorder vertex ordering of $G$. [1 mark]



Figure 3: Digraph and its adjacency list for Question 5