# Final Exam: CSC241-Section II (Data Structure and Algorithms)

## Date: 12/16/2021, Duration: 110 Min.

**Special Instruction:** Please read the instruction below:

1. Your answer will be graded based on correctness and clarity. Keep your answer precise and to the point. Do not provide irrelevant/unnecessary answers. If it is a True/False question, simply write True or False. If it is an MCQ question, only write the choice you select.
2. This is an open book/materials exam. However, discussion with anyone else is not allowed. You must provide a reference from the source you have taken help and should be able to explain your answer clearly to the instructor.
3. **Exam duration is 110 minutes. You will get 10 min extra to scan (for handwritten answers)/upload your script. Upload your answer as a single file by 12.30 PM, 12/16/2021. D2L will be locked after 12.31PM and will not accept any submission.**
4. Don't submit multiple files and don't use any format other than pdf or Docx.
5. If any question asks for justification of your answer/claim, you may receive a 0 if you merely provide an answer without justification.
6. No change or announcement on the D2L will be made (regarding questions) once it is published. If you think anything is wrong or not clear, state your assumption clearly, and then complete your answer.
7. All questions in a section carry equal weights unless stated otherwise.

---

**Question 1 (3+3+4 = 10 Points):** Consider a tree with which has one root node ***R*** and several leaf and non-leaf nodes. Prove or disprove the following statements:

I. ***R*** will have the maximum height than any other nodes.
II. Let us consider ***L*** is a random leaf node. L will have the maximum depth.
III. The height of a tree can be calculated recursively.

**Question 2 (10+10=18 points):** Let there is an undirected graph with 10 nodes with the following edges (x-y means x and y are connected):
1-4, 1-2, 2-3, 2-5, 2-6, 4-3, 5-6, 5-7. Now,

1) Draw the adjacency matrix representation of this graph.
2) We want to determine the In-degree of a specific node from this table. What is the time complexity?
3) We want to determine the Out-degree of a specific node from this table. What is the time complexity?

**Question 3 (5 + 6 + 5 = 16 Points):** Let there are 1 million integer numbers. They are stored in an array randomly. To scan the content of any array cell takes $1 nano\ seconds$. Now, answer the following questions:

I. How long it will take to find any random element from this array in the worst case?
II. Assume someone sorted this array is descending order. Now, how long it will take to find any random element from this array in the worst case?
III. Compared to part (II), Is it possible to make further improvement in the searching time? If yes, explain how much improvement can be achieved. If no, justify your reasoning.

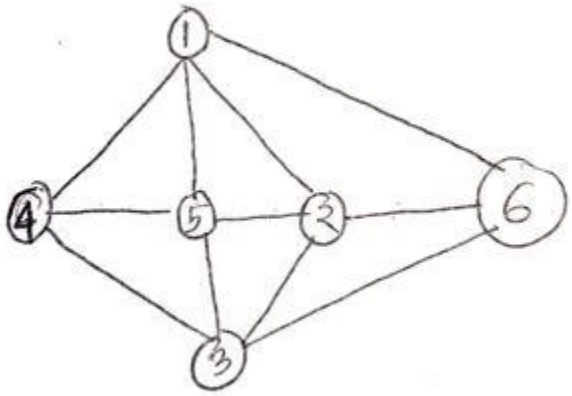
**Question 4 (16 Points):** Consider the Key-set, *S = [81, 102, 55, 51, 62, 36]* and a hash table of size 15, and their position marked from 0 to 14. We will consider the following math function to store a key on the hash table.

$$S(k) = S(k) \% 15$$

Here, $S(k)$ is any key from the Key-set. However, it will create Collison. To avoid this we will apply the linear and quadratic probing. Now answer the following questions:

I. What are the position of all the keys if we use linear probing?
II. What are the position of all the keys if we use quadratic probing?

**Question 5 (20 Points):** Consider the following figure. Draw the BFS tree considering 2 as the source node and mark each level. If you have multiple options while traversing, pick the node with smallest index.




**Question 6 (20 Points):** Consider the figure from the previous Question. Draw the DFS tree considering 5 as the source node. Mention all the back edges. If you have multiple options while traversing, pick the node with smallest index.