Data Structures and Algorithms – (COMP SCI 2C03)
Fall, 2021
Assignment 3

Due at 11:59pm on November 15th, 2021

- **No late assignment accepted.**
- Make sure to submit a version of your assignment ahead of time to avoid last minute uploading issues.
- Submit one assignment solution as a PDF file on Avenue.
- If the solution submitted by any student is identical to another student, both students will get a zero mark on the assignment.
- Present your algorithms in Java or Pseudocode (Pseudocode is preferred).
- **You may directly use methods discussed in class in your code (for example BFS, DFS, Topological Sort etc); that is, there is no need to give the code for these methods.**
- It is advisable to start your assignment early.

This assignment consists of 4 questions, and is worth 20 marks.

1. How many compares could it take, in the worst case, to insert N keys into an initially empty table of size $2N$, using linear probing? Explain your answer. [4 marks]

2. The **girth** of a graph is the length of its shortest cycle. If a graph is acyclic, then its girth is infinite. Give the pseudocode (or JAVA code) for the method $girth()$, which when given a graph $G = (V, E)$ returns

the girth of the graph. Hint : Run BFS from each vertex. The shortest cycle containing s is a shortest path from s to some vertex v, plus the edge from v back to s. [6 marks]

3. Given a connected graph, give the the pseudocode (or JAVA code) of an algorithm that runs in $O(|V|+|E|)$ using DFS to find a vertex whose removal (deleting the vertex and all incident edges) does not disconnect the graph. Here you need to comment on why your algorithm runs in $O(|V|+|E|)$. Hint: run DFS from some vertex s and consider the first vertex in DFS that finishes. [5 marks]

4. Given a Directed Acyclic Graph (DAG) and two distinguished vertices s and t, give the outline of an algorithm that runs in $O(|V|+|E|)$ to compute the number of directed paths from s to t. Here you need to comment on why your algorithm runs in $O(|V|+|E|)$. Hint: topological sort. [5 marks]