Tutorial 1
Sorting and Graph Algorithms

Date: 17/12/2018   **Total Marks: 25 marks**

Q1. Under what condition can there be more than one topological ordering for a given DAG? Another way of stating the question is to ask, under what conditions is the topological ordering of a DAG unique?   **(4 marks)**

Q2. Suppose we choose the median of five items as the pivot in quicksort. If we have an N element array, then we find the median of the elements located at the following positions: left (= 0), right (= N – 1), center (the average of left and right, rounded down), leftOfCenter (the average of left and center, rounded down), and rightOfCenter (the average of right and center, rounded down). The median of these elements is the pivot. What is the worst case running time of this version of quicksort?   **(3 marks)**

Q3. Show the steps required to do a radix sort on the following set of values when using base 10. $346, 22, 31, 212, 157, 102, 568, 435, 8, 14, 5$ **(3 marks)**

Q4. Minimum spanning tree (MST) Given a weighted, undirected graph with |V| nodes, answer the following as best as possible, with a brief explanation. Assume all weights are non-negative.
                                                                                  (5 marks)

a)   If each edge has weight ≤ w, what can you say about the cost of an MST?

b)   If the cost of an MST is c, what can you say about the shortest distances returned by Dijkstra's algorithm when run with an arbitrary vertex s as the source?

Q5. Find the strongly connected components for the given graph   **(10 marks)**