United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

Final Exam Total Marks: **40** Fall 2022

Course Code: CSE 2217 Course Title: Data Structure and Algorithms II

Time: 2 hours

Any examinee found adopting unfair means will be expelled from the trimester / program as per UIU disciplinary rules.

There are **six** questions. **Answer all of them**. Show full simulation/tabulations wherever necessary. Figures in the right-hand margin indicate full marks.

1. **(a)** What will be the best choice of algorithm for finding the shortest path between two vertices in the graph in Figure 1? Why is this choice better than other shortest path algorithms? **[2]**

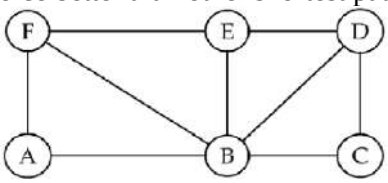

Figure 1: An undirected graph

(b) Find the shortest path tree from A in the graph in Figure 1 using your proposed algorithm. **[2]**

(c) Every connected directed acyclic graph (DAG) has exactly one topological ordering" - is it true or false? Explain your answer briefly by designing a graph G with exactly 4 vertices that justifies your reasoning. **[2]**

2. **(a)** Use the disjoint-sets data structure to identify the number of connected components in the graph G = (V; E) where V = {v1, v2, v3, v4, v5, v6, v7, v8}and E = {(v1, v2), (v2, v3), (v5, v6), (v4, v7), (v6, v7), (v6, v8)}. Inspect edges in the order they appear in E in your simulation. **[2]**

(b) Draw the resultant forest after performing each of the following operations sequentially in the disjoint set of Figure 2 **using union-by-rank and path-compression**. **[3]**

(i) Find_Set(6)
(ii) Union(8, 1)

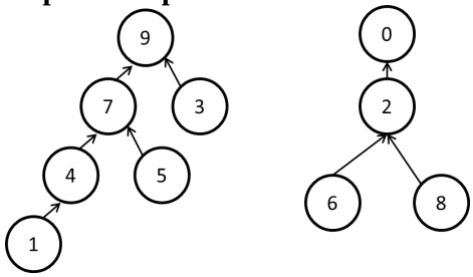

Figure 2: Disjoint set rooted tree implementation

(c) What is the advantage of using union-by-rank heuristic in a disjoint set? Explain your answer with an example. **[2]**

3. **(a)** Find the MST from the following graph (Figure 3) using Prim's algorithm (**start from node C**). Show all the necessary steps to justify your answer. **[3]**

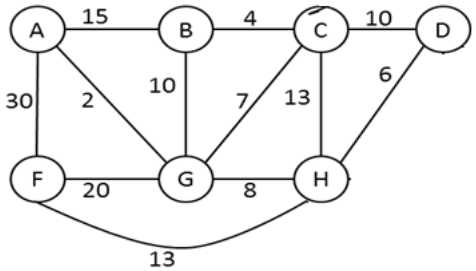

Figure 3: An undirected graph

(b) Suppose you are given a weighted graph where multiple edges have the same weight. You are asked to apply **Kruskal's algorithm** to find MST from that given graph. You have chosen the merge sort algorithm to sort the edges in ascending order. "*Depending on the sequence of the sorted edges, you may have different MSTs*". Is the statement True or False? Justify your answer. **[2]**

(c) What will be the runtime complexity of Kruskal's algorithm if we use bubble sort to sort edges (Sorting n elements with bubble sort takes time $O(n^2)$)? **[2]**

4. **(a)** A graph contains the vertices {1, 2, 3, 4, 5, 6, 7} and the shortest path from 1 to 7 is 1→3→2→4→5→7→6. Is it possible to find the shortest path from 2 to 7 from given data? Justify your answer. **[2]**

(b) Explain why a priority queue instead of a regular queue (FIFO) is used in Dijkstra's algorithm. **[2]**

(c) Find the **Shortest path tree** for the given graph in Figure 4, where the source is vertex **b**. Show the details of your calculation. **[3]**

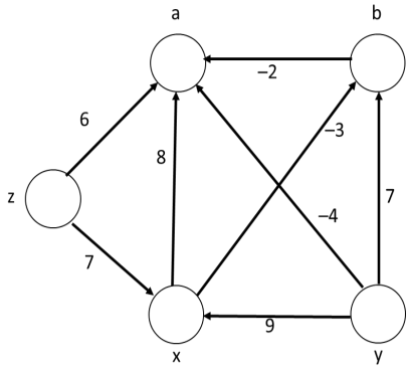

Figure 4: A directed graph G(V,E)

5. **(a)** What are the advantages of open addressing vs chaining for collision resolution? **[2]**

(b) Consider the hash function: ***h(k,i) = (h1(k) + ih2(k)) mod 7***

where ***h1(k) = (3k + 3) mod 7*** *and* ***h2(k) = (k+3) mod 7***

By proper calculations, redraw the following table (Table 1) and show the following sequence of operations with proper hash value calculations.

i. Insert 60 **[1]**

ii. Insert 54 **[1]**

iii. Delete 14 and replace with NIL **[1]**

iv. Search 7 **[1]**

0	1	2	3	4	5	6
9	NIL	7	14	NIL	21	NIL

Table 1: A hash table

If your search of 7 fails despite being present at the table, what might the possible reason be? **Explain** how you can modify the delete operation to prevent this from happening. **[1]**

6. **(a)** Provide an example to demonstrate that the worst case of Rabin Karp Algorithm can be O((n-m+1) * m). **[2]**

(b) Given a Text String: "***BATAC"*** and a Pattern: ***"AT",*** use Rabin-Karp's algorithm to find whether the pattern exists in the string or not. You **must** show the **Hash Values** and **calculations for all the substring.** Use **q=7** to mod in the rolling hash function. **[4]**

The values of each character as well as supplementary information are given below:

Char	A	B	C	T
Value	1	2	3	4