United International University (UIU)

Dept. of Computer Science & Engineering (CSE)

Final Exam Total Marks: **40** Fall 2023

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.

First determine X and Y correctly for your student ID and write it down. Use these values in Questions 1.

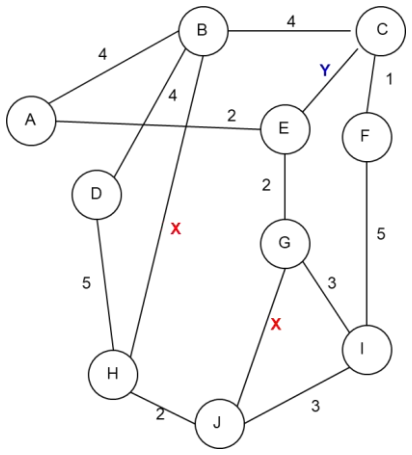
For example, a student with ID: **0111 142 001**

A B

A=142, **B**=1

X = 2 + (142 mod 6) = 2+4 = 6

Y = 2 + (1 mod 5) = 2+1 = 3

1.	**(a)** Find the Minimum Spanning Tree (MST) for the given graph in the following figure using Prim's algorithm. Show the details of your calculation.  	**[3]**
	(b) Suppose you are asked to utilize a disjoint set data structure to implement Kruskal's algorithm to find MST from a given graph. Explain, with an example, how disjoint set data structure would help you to perform the following operations: i) joining two trees in the forest ii) detecting a cycle	**[3]**
2.	**(a)** In the Rabin-Karp Algorithm, why does it convert the strings into numeric values?	**[1]**
	(b) "There is no difference between the Rabin-Karp Algorithm and the Naive Approach of Pattern Matching in terms of Worst Case Scenario." - Do you agree with the statement? Give proper justification.	**[1]**
	(c) Imagine you are working on a database search engine that aims to efficiently retrieve information from a large dataset of product codes. Each product code is a combination of letters A through J, representing different product categories. Your task is to implement the Rabin-Karp	**[3]**

algorithm to find occurrences of a specific product code pattern within the dataset.

The numeric values of the letters of the product code:

A	B	C	D	E	F	G	H	I	J
1	2	3	4	5	6	7	8	9	10

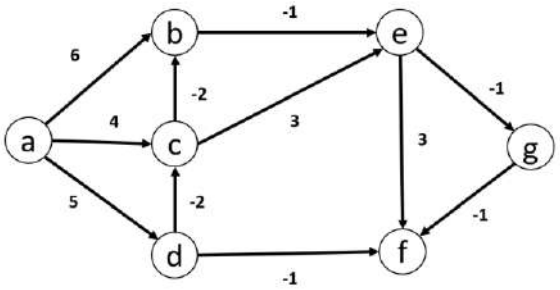
The hash function is defined as follows:
hash(s) = s[0] * 10^(n-1) + s[1] * 10^(n-2) + …… + s[n-1]*10^(n-n)
Where,

hash(s) is the hash value of string
n is the length of the string
10 is the base of the hash function.

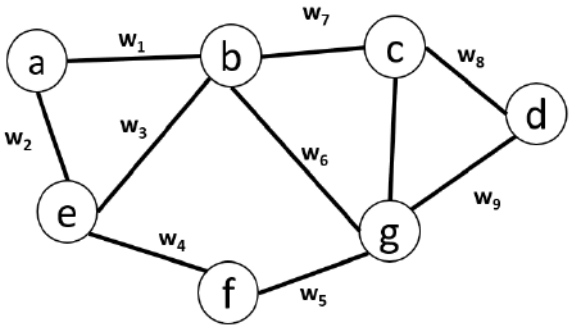
You are given a dataset of product codes, for example, "HGJABCDFGH," and you need to efficiently identify occurrences of a specific product code pattern within it. The pattern you are looking for is "CDFG". Clearly show the step-by-step calculations for the hash values, modulo operations, and the final results.

3. **(a)** "The Disjkstra's Algorithm might fail on graphs with negative edge weights" - do you agree with the statement? Justify your answer using an example. **[2]**

(b) Does the following graph contain any negative weight cycles? Justify by applying the Bellman Ford Algorithm. **[5]**



(c) Consider the following graph. Redraw the graph and assign the values of w_1, w_2, w_3, w_4, w_5, w_6, w_7, w_8 and w_9 in such a way that the BFS algorithm can be used on the graph to determine the shortest path from vertex A to all other vertices. **[1]**



(d) Apply BFS on the graph you generated in Question 3c considering the vertex *a* as the source vertex. Show the parent values of each vertex and draw the minimum spanning tree that is obtained based on the parent values. **[2]**

4.	**(a)** The following table shows the parent array of a Disjoint set (Rooted tree implementation). Perform the following operations sequentially using **path compression and union-by-rank heuristic:** i. Draw the disjoint set forest ii. What will be returned by Find-Set(6), and Find-Set(5)? iii. Redraw the forest after Union(0, 7) iv. Redraw the forest after Union(2, 9) **Index** 0 1 2 3 4 5 6 7 8 9 10 11 **Parent** 6 4 3 4 4 8 3 7 10 8 10 8 **(b)** What is the time complexity of Make-Set(x), Union(x,y) and Find-Set(x) operations in Disjoint Sets? Can you name one application where we use Disjoint Sets?	**[2]** **[1]** **[1]** **[1]** **[2]**
5.	**(a)** Draw the 11-item hash table that results from using the hash function $h(k, i) = (h'(k) + 2i^2)$ ***mod*** 11, where $h'(k) = k$ ***mod*** 11, to hash the keys 50, 3, 6, 17, and 61. Assume that collisions are handled by open addressing. What kind of clustering did you encounter? **(b)** State the difference between Direct-address Tables and Hash Tables. How do we deal with collisions in Hash tables? Describe four collision resolution techniques with proper examples.	**[4]** **[3]**
6.	**(a)** Explain the concept of polynomial-time reduction. How is it used to establish the relationship between different complexity classes? **(b)** Explain the concept of NP-Completeness. What does it mean for a problem to be NP-complete?	**[2]** **[3]**