UNIVERSITY OF BIRMINGHAM

School of Computer Science

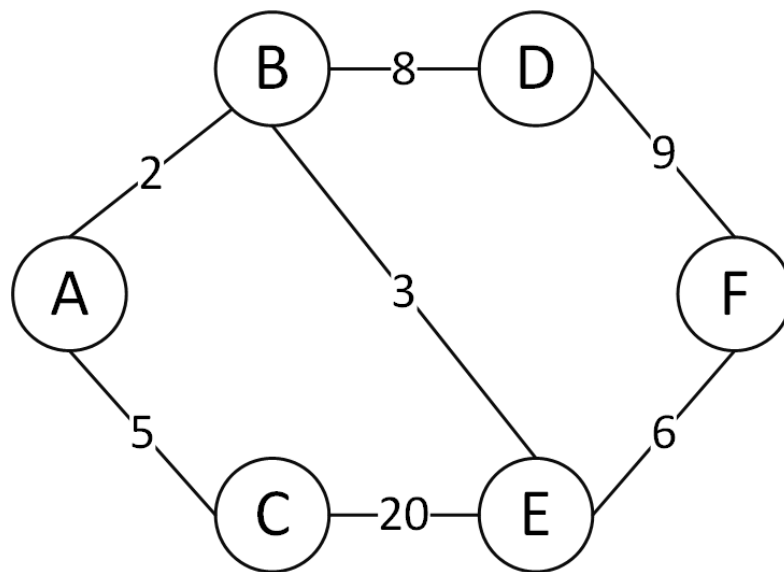**Data Structures, Algorithms & Databases**

Class Test 3, April, 2023

Data Structures, Algorithms & Databases

Answer ALL questions below. There are total 20 marks in this class test.

Question 1 Undirected Graph and Minimal Spanning Tree

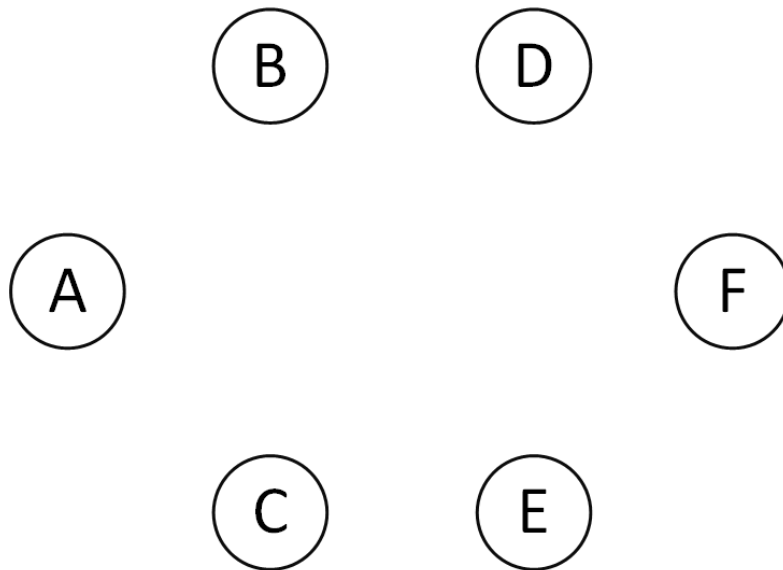**Part 1** Consider the following weighted undirected graph (with 6 vertices and 7 edges):

Represent the above graph with an **Adjacency List**:   **[3 marks]**

$N[v]$	Neighbour(s)
A	
B	
C	
D	
E	
F	

Part 2 Construct a **Minimal Spanning Tree** (MST) for the above graph using the Jarnik-Prim's algorithm, and the starting node = A.

Draw the final MST and indicate its total weight. You are not required to draw the complete graph for each step of the algorithm. Just indicate the selected edges (like A—B) that become part of the MST along with their weights. **[2 marks]**

B   D

A   F

C   E

Total Weight: ____

Question 2 Directed Graph and the Shortest Path

Consider the following weighted directed graph (with 6 vertices and 9 edges):
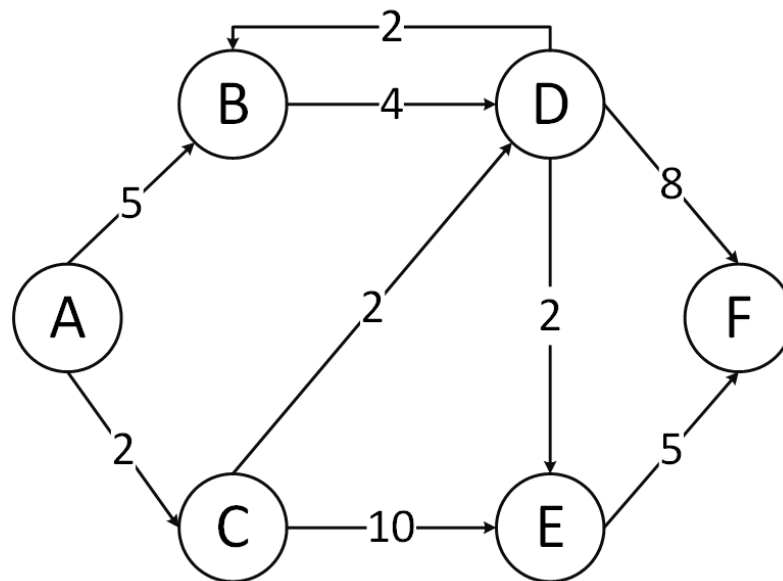
Calculate the **shortest path** from A to F using the Dijkstra's algorithm. ("Shortest" means the path with the lowest total weight.) **[5 marks]**

You are expected to show your work using a table of the following form and also list the shortest path (e.g. $A \longrightarrow B \longrightarrow C$) and specify the resulting total weight:

A	B	C	D	E	F	Finished
0,A	∞,B	∞,C	∞,D	∞,E	∞,F	

Total Weight:
Shortest Path:

Question 3 Sorting

Part 1 For a given array $A = [10, 13, 21, 26, 41, 55, 56, 25, 72]$, which of the following statement is true? **[2 marks]**

(A) Even though it is a nearly sorted array, the performance of QuickSort (by using the first element as the Pivot) would be the same as MergeSort.

(B) Since the length of the array is very short, it doesn't really matter which sorting algorithm we select between MergeSort and HeapSort (They have the same space performance).

(C) Random Pivot selection could potentially improve the performance of the QuickSort, even if this array is nearly sorted.

(D) When applying QuickSort, we only need to go through one partitioning pass since the array is nearly sorted.

Answer:____

Part 2 Which of the following arrays represents a binary heap? **[2 marks]**

(A) $[49, 21, 21, 21, 22, 11, 10]$

(B) $[5, 6, 7, 6, 7, 7, 8]$

(C) $[18, 14, 9, 16, 14, 11, 10]$

(D) $[9, 10, 8, 4, 12]$

Answer:____

Part 3 Shown below is an array (size=6). Carry out a sorting operation with the **Quick Sort** algorithm to obtain ascending order. Use the **first** element as the *Pivot*, and show the result after each partitioning pass (process the left partition first). **[6 marks]**

Index:	0	1	2	3	4	5
	20	15	5	25	30	10