UNIVERSITY OF BIRMINGHAM

School of Computer Science

Data Structures, Algorithms & Databases

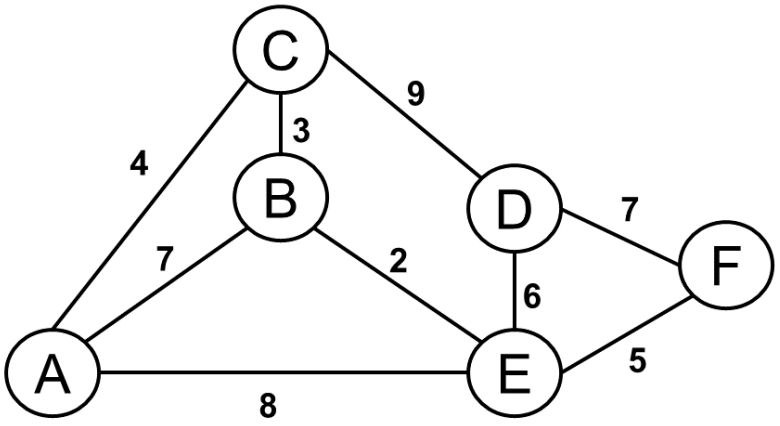
Class Test #3 [2023-24]

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 9 edges):

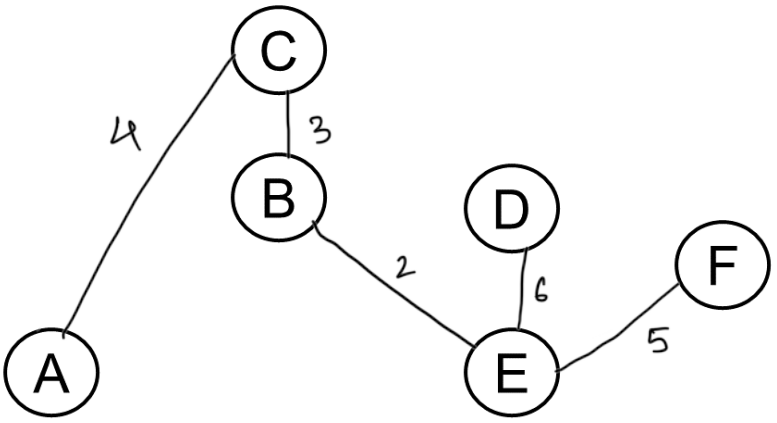


Represent the above graph with an **Adjacency List**: **[3 marks]**

$N[v]$	Neighbour(s)
A	B[7], C[4], E[8]
B	A[7], C[3], E[2]
C	A[4], B[3], D[9]
D	C[9], E[6], F[7]
E	A[8], B[2], D[6], F[5]
F	D[7], E[5]

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

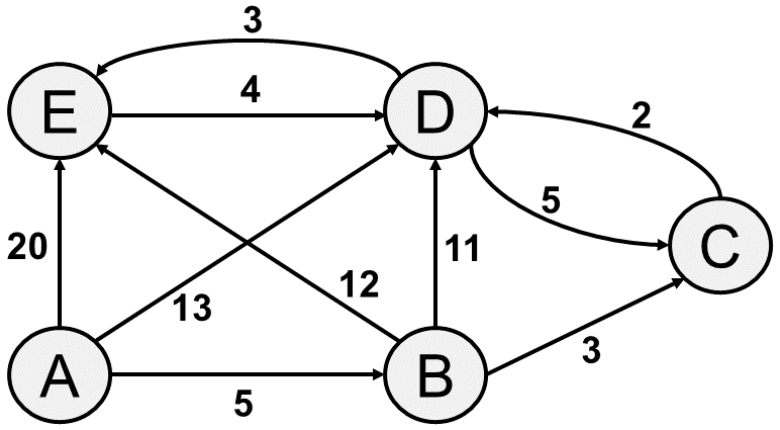
Draw the final MST and indicate its total weight. You are not required to draw the complete graph for each step of the algorithm. Just indicate the selected edges (like A—B) that become part of the MST along with their weights. **[2 marks]**



Total Weight: 20

Question 2 Directed Graph and the Shortest Path

Consider the following weighted directed graph (with 5 vertices and 10 edges):



Calculate the **shortest path** from *A* to *E* 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⟶B⟶C) and specify the resulting total weight:

A	B	C	D	E	Finished
0,A	∞,B	∞,C	∞,D	∞,E	
0,A	5,A	∞,C	13,A	20,A	A
0,A	5,A	8,B	13,A	17,B	B
0,A	5,A	8,B	10,C	13,C	C
0,A	5,A	8,B	10,C	13,d	D
0,A	5,A	8,B	10,C	13,d	E

Total Weight: 13
Shortest Path: A,B,C,D,E

Question 3 Hash Tables

Consider the following two hash functions `hash` (resp. `hash1`) and `hash2` as given by the following table:

key	A	B	C	D	E	F
hash/hash1	1	1	2	2	3	3
hash2	4	0	2	3	2	3

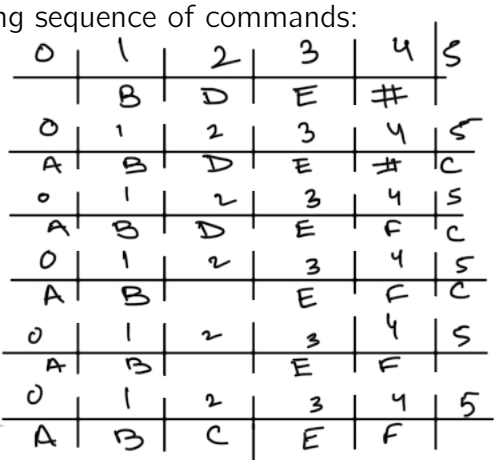
Also, consider the following initial hash table:

0	1	2	3	4	5
	B	D	E	#	

empty

and the following sequence of commands:

1. insert(A)
2. insert(C)
3. insert(F)
4. delete(D)
5. delete(C)
6. insert(C)



linear probing

Show the state of the hash table after each command, respectively using the following two collision resolution strategies:

- linear probing **[5 marks]**
- double hashing **[5 marks]**

Hint: the answer to each of these two questions must be a sequence of tables, with one table after each operation in the sequence.

double hashing