King Fahd University of Petroleum and Minerals
ICS Department

ICS-202 Data Structures

Assignment #4

ICS 202 – Data Structures
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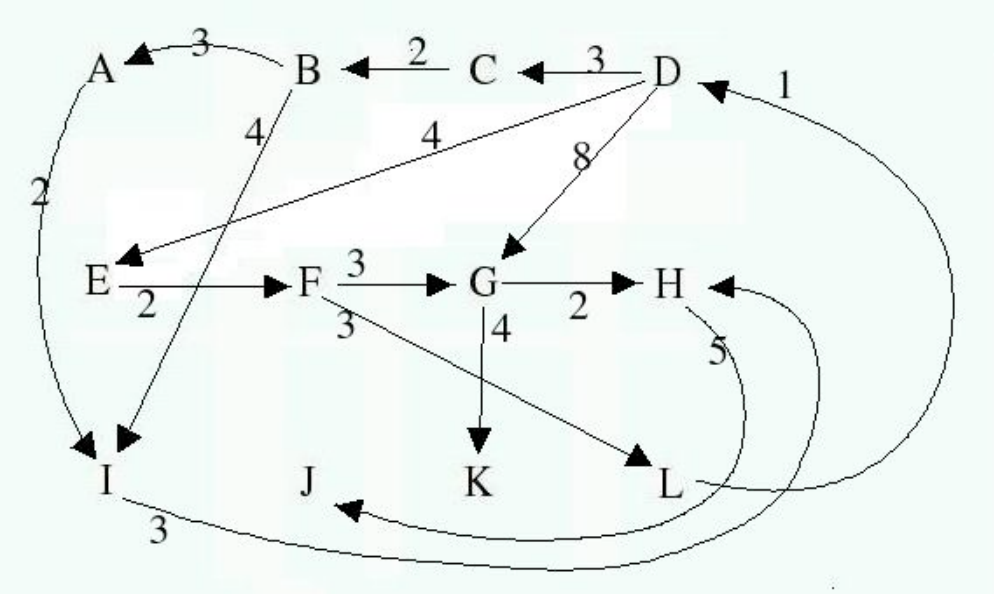
Due on Saturday Dec 11, 2021 – Midnight

Given the following Graphs:

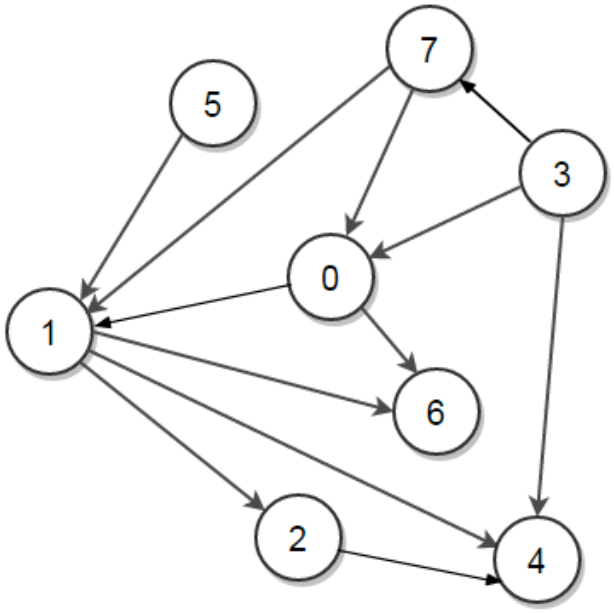
Graph A:



Graph B:

Graph B is the undirected version of Graph A.

Graph C:



Question#1 [40 points]

For each of the graphs: graph A, and graph B, answer the following questions:

(a) List the vertices in the order they will be visited using pre-order depth-first traversal, starting from vertex B. (Ignore the weights on the graph)

(b) List the vertices in the order they will be visited using post-order depth-first traversal, starting from vertex B. (Ignore the weights on the graph)

(c) List the vertices in the order they will be visited using breadth-first traversal, starting from vertex B. (Ignore the weights on the graph)

(d) Only for graph A, List the vertices in the order they will be visited using Topological order traversal. Draw the resulting topological sorted graph. If topological sorting is not possible give the reason.

(e) For graph C, List the vertices in the order they will be visited using Topological order traversal. Draw the resulting topologically sorted graph. If topological sorting is not possible give the reason.

Note 1: In the traversals, if at any point there is more than one possible vertex to visit, visit them in alphabetical order.

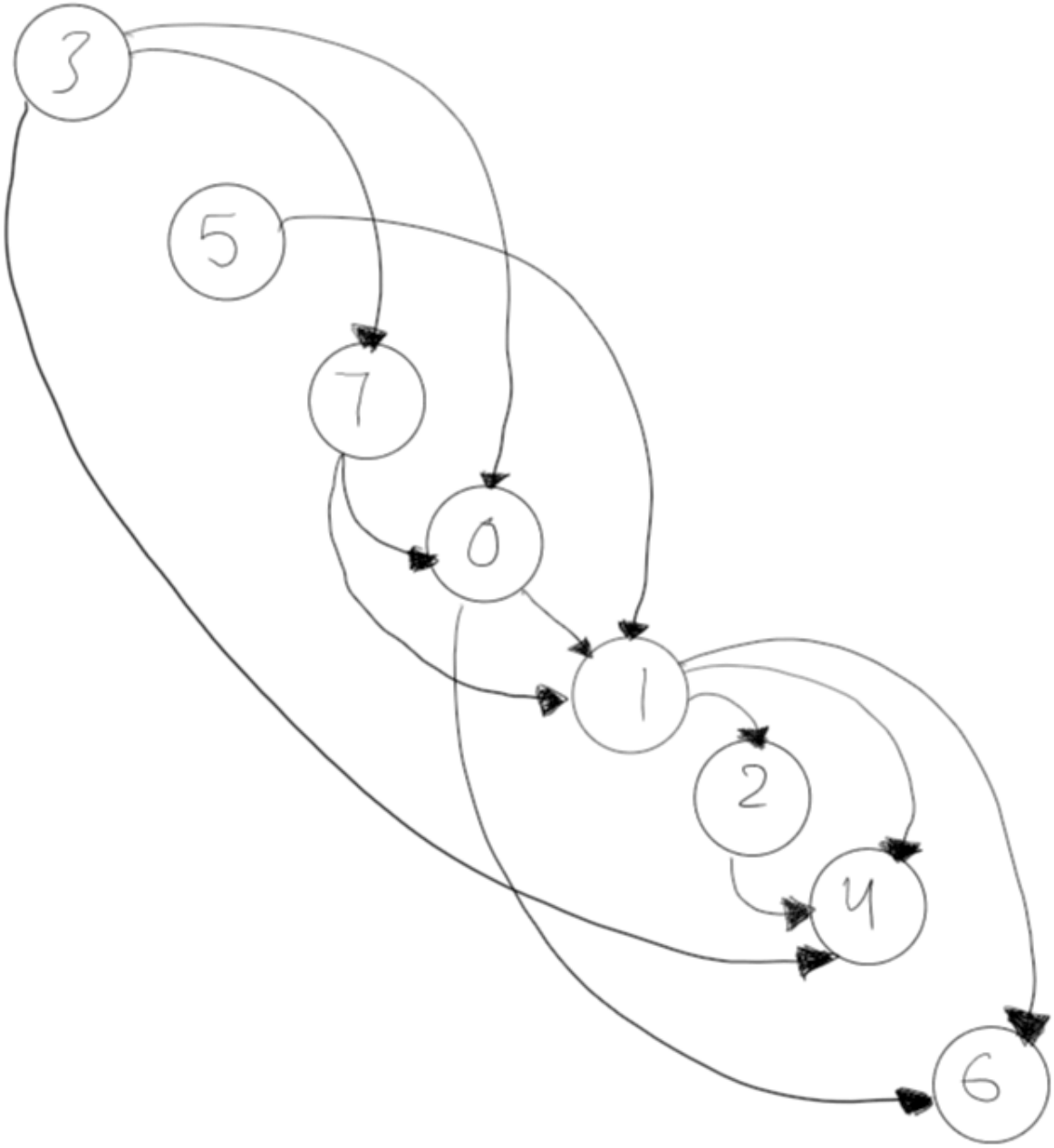
Note 2: In some traversals, some vertices may NOT be visited.

Pre-Order	Graph A 5 points	B, A, I, H, J
	Graph B 5 points	B, A, I, H, G, D, C, E, F, L, K, J
Post-Order	Graph A 5 points	J, H, I, A, B
	Graph B 5 points	C, L, F, E, D, K, G, J, H, I, A, B
Breadth-first	Graph A 5 points	B, A, I, H, J
	Graph B 5 points	B, A, C, I, D, H, E, G, L, J, F, K
Topological Order (if possible)	Graph A 2 points	None of the nodes is visited
Topological Order (if possible)	Graph C 5 points	3, 5, 7, 0, 1, 2, 4, 6

Resulting topological sorted graph for Question 1d if any:

Because the in-degree of all of the nodes is greater than zero, so the algorithm is stopped.

3 points Resulting topologically sorted graph for Question 1e if any:

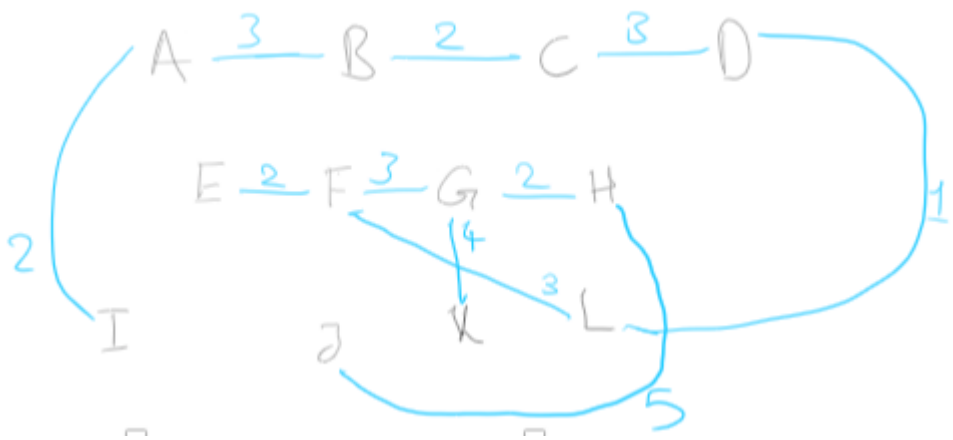


Question#2 [10 points]

Use the graph B above to find the minimum-cost spanning tree using Kruskal's algorithm. Show the table and draw the resulting spanning tree. (Y -> YES, N-> NO)

(1 point for each correct column, 5 points for the tree.)

Edge	**DL**	**AI**	**BC**	**EF**	**GH**	**AB**	**CD**	**FG**	**FL**	**HI**	**BI**	**DE**	**GK**	**HJ**	**DG**
Weight	1	2	2	2	2	3	3	3	3	3	4	4	4	5	8
Insertion Status	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	N
Insertion order	1	2	3	4	5	6	7	8	9				10	11	

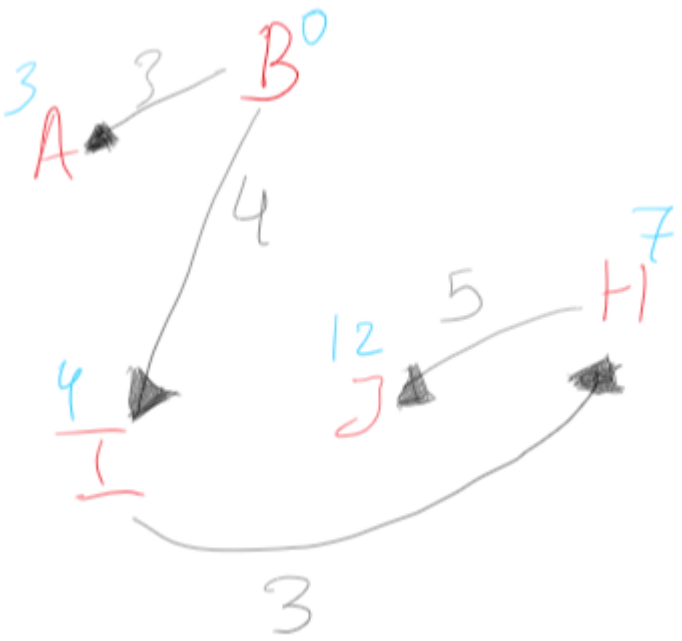


Minimum cost: 30

Question#3 [18 points]

Use the graph A above to trace the execution of Dijkstra's algorithm as it solves the shortest path problem starting from vertex B. Show the table and draw the resulting weighted graph.
(1 point for each correct row, 2 points for the correct predecessor column, and 4 points for tree.)

Pass	Initially	1	2	3	4	5	Weight	Predecessor
Active vertex		B	A	I	H	J		
A	∞	3	#	#	#	#	3	B
B	0	#	#	#	#	#	0	-
C	∞	∞	∞	∞	∞	∞	∞	-
D	∞	∞	∞	∞	∞	∞	∞	-
E	∞	∞	∞	∞	∞	∞	∞	-
F	∞	∞	∞	∞	∞	∞	∞	-
G	∞	∞	∞	∞	∞	∞	∞	-
H	∞	∞	∞	7	#	#	7	I
I	∞	4	4	#	#	#	4	B
J	∞	∞	∞	∞	12	#	12	H
K	∞	∞	∞	∞	∞	∞	∞	-
L	∞	∞	∞	∞	∞	∞	∞	-



Question#4 [24 points]

Use the hash function h(x) = x mod 11 to load the following values 25, 14, 36, 47 using each of following to resolve collisions:
(-2 for any wrong cell)

(a) **c(i) =** $\pm i$

index	0	1	2	3	4	5	6	7	8	9	10
	33		36	25	14	47					21

$h_i(x) = (h(x) \pm i) \% 11$

$h_0(25) = (3 \pm 0) \% 11 = 3$

$h_0(14) = (3 \pm 0) \% 11 = 3$ Collision

$h_1(14) = (3+1) \% 11 = 4$

$h_0(36) = (3 \pm 0) \% 11 = 3$ Collision

$h_1(36) = (3+1) \% 11 = 4$ Collision

$h_{-1}(36) = (3-1) \% 11 = 2$

$h_0(47) = (3+0) \% 11 = 3$ Collision

$h_1(47) = (3+1) \% 11 = 4$ Collision

$h_{-1}(47) = (3-1) \% 11 = 2$ Collision

$h_2(47) (3+2) \% 11 = 5$

c(i) = $\pm i^2$

index	0	1	2	3	4	5	6	7	8	9	10
	33		36	25	14			47			21

$h_0(25) = (3 \pm 0) \% 11 = 3$

$h_0(14) = (3 \pm 0) \% 11 = 3$ Collision

$h_1(14) = (3+1) \% 11 = 4$

$h_0(36) = (3 \pm 0) \% 11 = 3$ Collision

$h_1(36) = (3+1) \% 11 = 4$ Collision

$h_{-1}(36) = (3-1) \% 11 = 2$

$h_0(47) = (3+0) \% 11 = 3$ Collision

$h_1(47) = (3+1) \% 11 = 4$ Collision

$h_{-1}(47) = (3-1) \% 11 = 2$ Collision

$h_2(47) = (3+4) \% 11 = 7$

c(i) = $i * h_p(x)$ where $h_p(x) = 1 + x \bmod 10$

index	0	1	2	3	4	5	6	7	8	9	10
	33			25		47	36		14		21

$h_0(25) = (3 + 0) \% 11 = 3$

$h_0(14) = (3 + 0) \% 11 = 3$ Collision

$h_p(14) = 1 + 14 \% 10 = 5$

$h_1(14) = [3 + (1 \times 5)] \% 11 = 8$

$h_0(36) = (3 + 0) \% 11 = 3$ Collision

$h_p(36) = 1 + 36 \% 10 = 7$

$h_1(36) = [3 + (1 \times 7)] \% 11 = 10$ Collision

$h_2(36) = [3 + (2 \times 7)] \% 11 = 6$

$h_0(47) = (3 + 0) \% 11 = 3$ Collision

$h_p(47) = 1 + 47 \% 10 = 8$

$h_1(47) = [3 + (1 \times 8)] \% 11 = 0$ Collision

$h_2(47) = [3 + (2 \times 8)] \% 11 = 8$ Collision

$h_3(47) = [3 + (3 \times 8)] \% 11 = 5$

Question#5 [8 points]

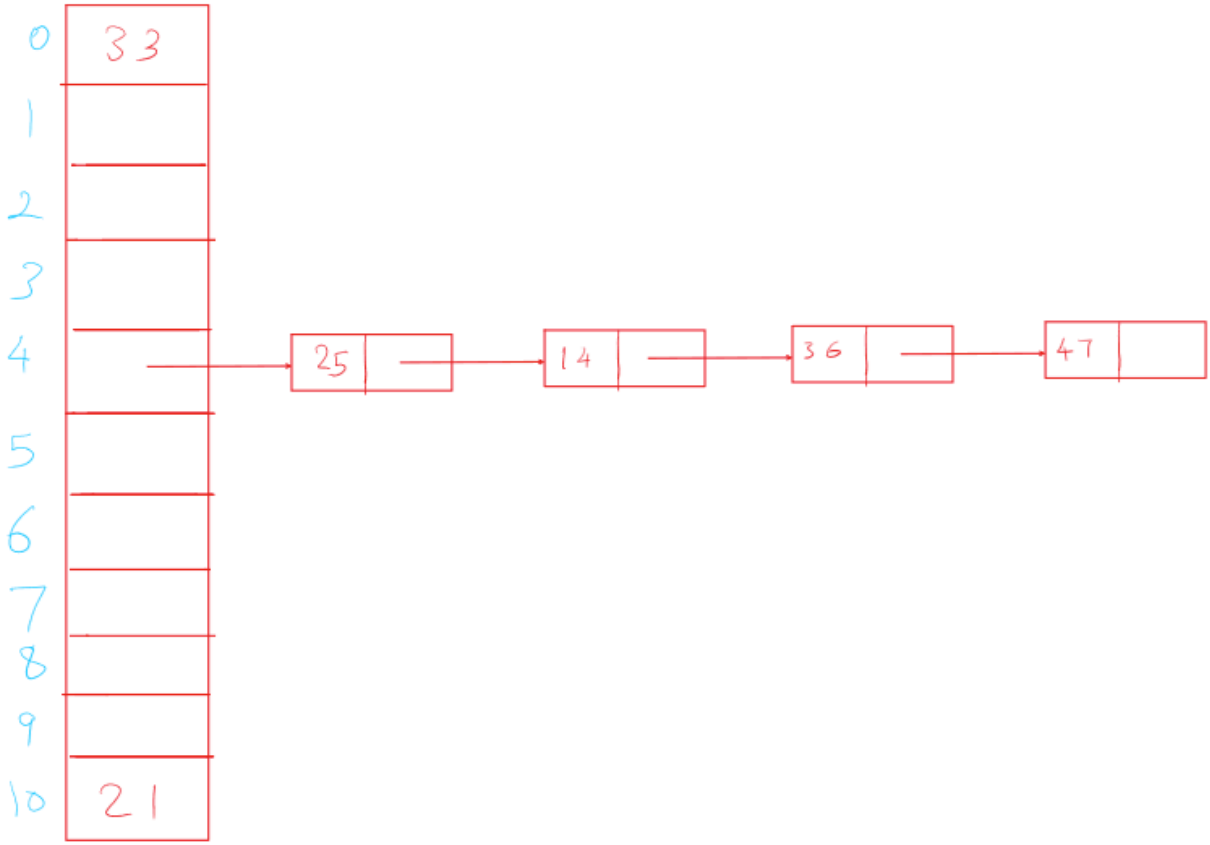
Use the hash function h(x) = x mod 11 to load the following values 25, 14, 36, 47 using separate chaining. (both add to head and ad to tail are ok)

h(25) = 25 % 11 = 3

h(14) = 14 % 11 = 3 Collision

h(36) = 36 % 11 = 3 Collision

h(47) = 47 % 11 = 3 Collision



Answer to all questions should be submitted as a soft-copy through the Blackboard. Hard copies are not required. All your homework files should be submitted without any compression.

For any questions, queries or clarifications regarding HW 4, please contact Dr. Emad Ramadan (eramadan@kfupm.edu.sa **) with HW4 in the subject line.**

END OF ASSIGNMENT