

Jackson State University
CSC 323 Algorithm Design and Analysis, Spring 2019
Instructor: Dr. Natarajan Meghanathan
Exam 3 (Take Home)

Maximum Points: 200

Due on: April 25th, 2019: 1 PM

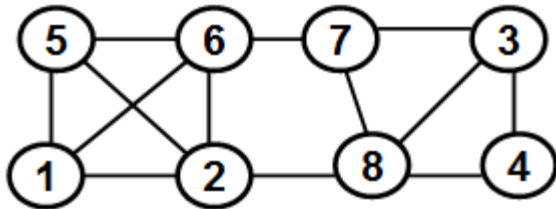
Print this exam and answer in the blank space/page provided after each question. You should staple your exam. Come to classroom ENB 212 at 1 PM (on April 25th) and submit the exam on time

Q1: 25 pts) For the graph assigned to you, find the following using the **approximation heuristics** discussed in class.

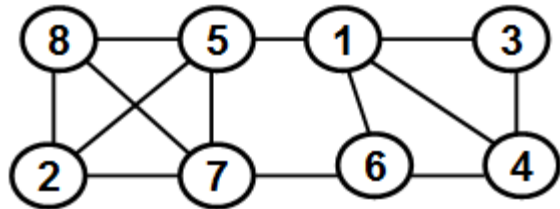
(a-7) Maximal Independent Set (b-2) Minimal Vertex Cover (c-8) Maximal Clique (d-8) Minimum Connected Dominating Set

Show all the work for each.

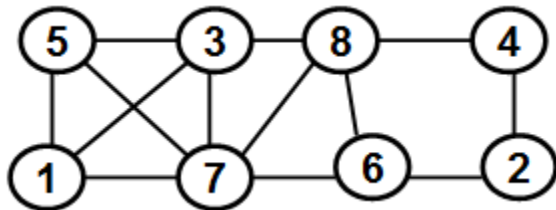
Brown, Demetrius



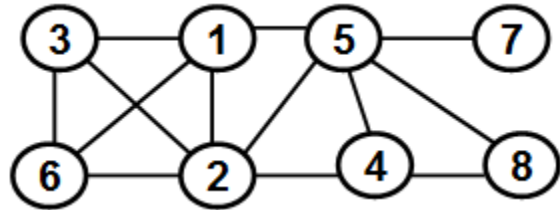
Cato, Jahelle



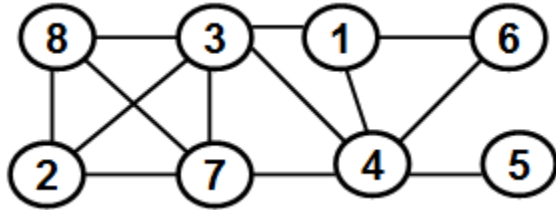
Chukwuma, Nzefili



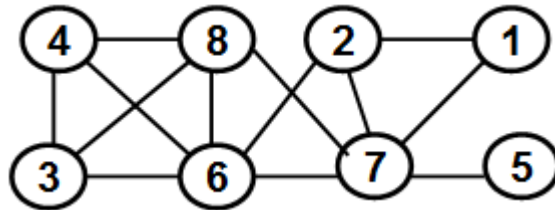
Clark, Armon



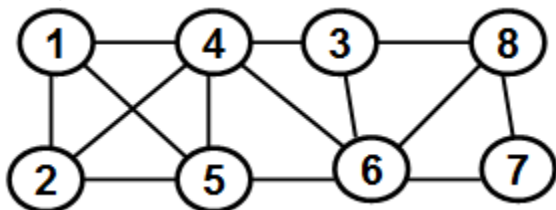
Collins, Taylor



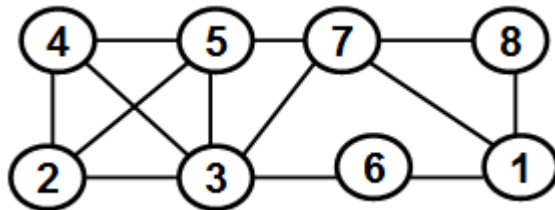
Harmon, Alfred



Langat, Vincent



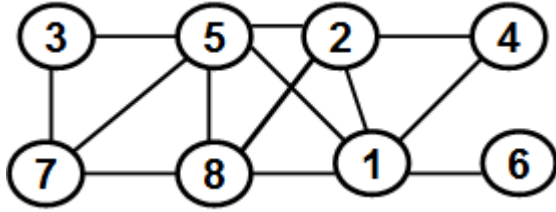
Stewart, Jessica



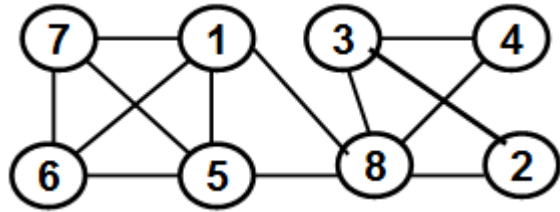
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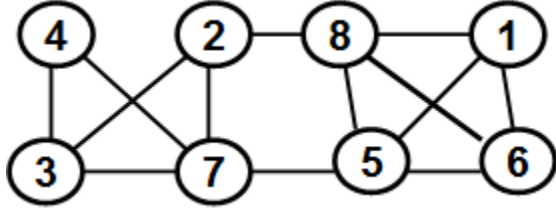
Tchakoua, Astride



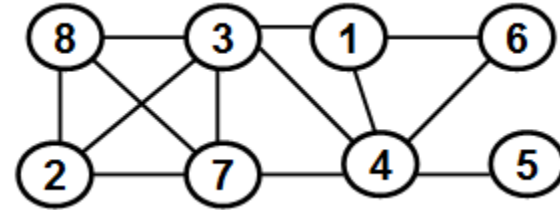
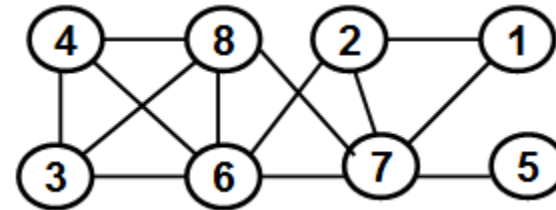
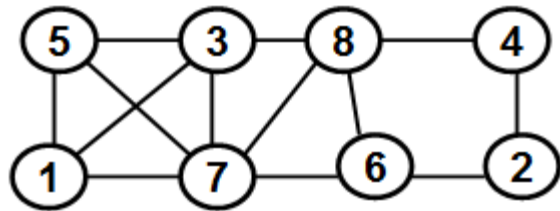
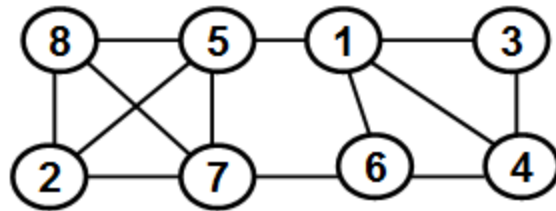
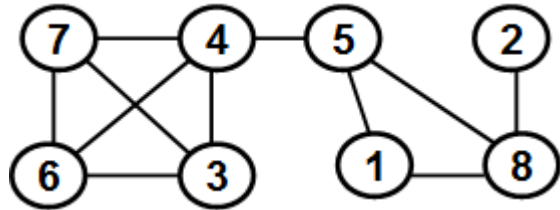
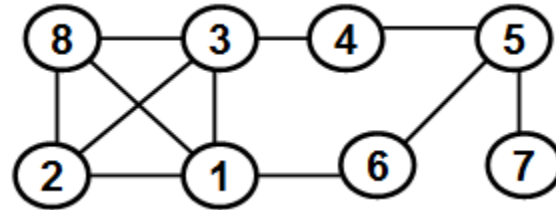
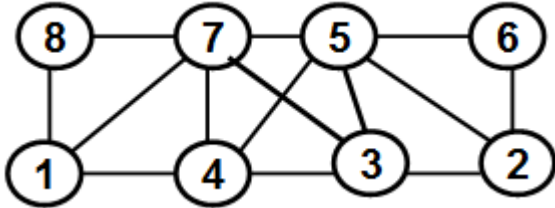
Washington, Daren



Wynn, Marcus



Jackson, Martice



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Q2: 25 pts) You are assigned the edge weight matrix for a complete graph. Determine an **approximation to the minimum weight tour** using the (i-8) Nearest neighbor heuristic (ii-12) Twice around the tree heuristic.

Also, show one attempt of reducing the tour weight using the 2-change heuristic for the tour obtained with each of the two heuristics.

Show all the work as well as clearly indicate the tour and its weight before and after the attempt of using the 2-change heuristic in each case.

Brown, Demetrius

	V1	V2	V3	V4	V5	V6
V1	0	9	15	1	8	6
V2	9	0	15	10	4	6
V3	15	15	0	9	13	4
V4	1	10	9	0	13	5
V5	8	4	13	13	0	13
V6	6	6	4	5	13	0

Cato, Jahelle

	V1	V2	V3	V4	V5	V6
V1	0	9	10	4	6	15
V2	9	0	3	1	7	2
V3	10	3	0	8	11	14
V4	4	1	8	0	11	15
V5	6	7	11	11	0	5
V6	15	2	14	15	5	0

Chukwuma, Nzewili

	V1	V2	V3	V4	V5	V6
V1	0	8	6	2	9	14
V2	8	0	4	14	5	9
V3	6	4	0	5	15	10
V4	2	14	5	0	12	10
V5	9	5	15	12	0	3
V6	14	9	10	10	3	0

Clark, Armon

	V1	V2	V3	V4	V5	V6
V1	0	10	2	14	12	14
V2	10	0	7	8	15	7
V3	2	7	0	7	14	12
V4	14	8	7	0	2	14
V5	12	15	14	2	0	14
V6	14	7	12	14	14	0

Collins, Taylor

	V1	V2	V3	V4	V5	V6
V1	0	2	10	15	14	6
V2	2	0	7	3	14	8
V3	10	7	0	12	3	15
V4	15	3	12	0	5	10
V5	14	14	3	5	0	8
V6	6	8	15	10	8	0

Harmon, Alfred

	V1	V2	V3	V4	V5	V6
V1	0	4	8	14	1	12
V2	4	0	4	7	14	15
V3	8	4	0	13	11	9
V4	14	7	13	0	5	6
V5	1	14	11	5	0	13
V6	12	15	9	6	13	0

Langat, Vincent

	V1	V2	V3	V4	V5	V6
V1	0	14	10	2	9	7
V2	14	0	1	2	13	12
V3	10	1	0	13	2	5
V4	2	2	13	0	15	3
V5	9	13	2	15	0	2
V6	7	12	5	3	2	0

Stewart, Jessica

	V1	V2	V3	V4	V5	V6
V1	0	11	5	5	6	14
V2	11	0	5	9	10	9
V3	5	5	0	2	6	12
V4	5	9	2	0	6	13
V5	6	10	6	6	0	2
V6	14	9	12	13	2	0

Tchakoua, Astride

	V1	V2	V3	V4	V5	V6
V1	0	6	12	15	15	12
V2	6	0	11	4	6	3
V3	12	11	0	3	5	12
V4	15	4	3	0	13	3
V5	15	6	5	13	0	3
V6	12	3	12	3	3	0

Washington, Daren

	V1	V2	V3	V4	V5	V6
V1	0	2	1	12	11	13
V2	2	0	7	12	8	6
V3	1	7	0	11	8	8
V4	12	12	11	0	6	12
V5	11	8	8	6	0	8
V6	13	6	8	12	8	0

Name: _____

J#: _____

Wynn, Marcus

	V1	V2	V3	V4	V5	V6
V1	0	3	7	2	2	3
V2	3	0	9	13	6	4
V3	7	9	0	12	7	9
V4	2	13	12	0	9	9
V5	2	6	7	9	0	9
V6	3	4	9	9	9	0

Jackson, Martice

	V1	V2	V3	V4	V5	V6
V1	0	8	14	4	10	15
V2	8	0	7	4	9	8
V3	14	7	0	5	12	14
V4	4	4	5	0	4	10
V5	10	9	12	4	0	2
V6	15	8	14	10	2	0

	V1	V2	V3	V4	V5	V6
V1	0	6	15	12	10	7
V2	6	0	11	12	8	1
V3	15	11	0	4	3	9
V4	12	12	4	0	6	13
V5	10	8	3	6	0	13
V6	7	1	9	13	13	0

	V1	V2	V3	V4	V5	V6
V1	0	6	8	4	2	5
V2	6	0	15	12	1	1
V3	8	15	0	8	15	4
V4	4	12	8	0	10	4
V5	2	1	15	10	0	6
V6	5	1	4	4	6	0

	V1	V2	V3	V4	V5	V6
V1	0	2	1	12	11	13
V2	2	0	7	12	8	6
V3	1	7	0	11	8	8
V4	12	12	11	0	6	12
V5	11	8	8	6	0	8
V6	13	6	8	12	8	0

	V1	V2	V3	V4	V5	V6
V1	0	10	2	14	12	14
V2	10	0	7	8	15	7
V3	2	7	0	7	14	12
V4	14	8	7	0	2	14
V5	12	15	14	2	0	14
V6	14	7	12	14	14	0

	V1	V2	V3	V4	V5	V6
V1	0	14	10	2	9	7
V2	14	0	1	2	13	12
V3	10	1	0	13	2	5
V4	2	2	13	0	15	3
V5	9	13	2	15	0	2
V6	7	12	5	3	2	0

	V1	V2	V3	V4	V5	V6
V1	0	8	6	2	9	14
V2	8	0	4	14	5	9
V3	6	4	0	5	15	10
V4	2	14	5	0	12	10
V5	9	5	15	12	0	3
V6	14	9	10	10	3	0

Name: _____

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Q3: 25 pts) For the edge weight matrix assigned to you for a directed graph, determine the shortest path weights between any two vertices of the graph using the **Floyd-Warshall algorithm**.

Show clearly the distance matrix and the predecessor matrix for each iteration.

Also, extract a path of length two or above between any two vertices of your choice. Clearly show the path extraction steps, as shown in the slides.

Brown, Demetrius

	V1	V2	V3	V4	V5
V1	0	7	14	∞	3
V2	∞	0	9	3	1
V3	12	∞	0	10	9
V4	∞	9	10	0	12
V5	3	3	∞	4	0

Cato, Jahelle

	V1	V2	V3	V4	V5
V1	0	7	5	3	∞
V2	∞	0	4	12	14
V3	4	3	0	9	∞
V4	1	6	5	0	∞
V5	∞	3	11	9	0

Chukwuma, Nzefili

	V1	V2	V3	V4	V5
V1	0	∞	2	4	11
V2	1	0	8	∞	1
V3	4	∞	0	8	3
V4	10	7	5	0	∞
V5	∞	15	10	9	0

Clark, Armon

	V1	V2	V3	V4	V5
V1	0	1	11	∞	9
V2	10	0	9	∞	10
V3	∞	5	0	5	14
V4	14	∞	13	0	11
V5	8	12	13	∞	0

Collins, Taylor

	V1	V2	V3	V4	V5
V1	0	∞	8	4	10
V2	8	0	14	4	∞
V3	14	12	0	5	∞
V4	2	∞	13	0	2
V5	3	∞	12	13	0

Harmon, Alfred

	V1	V2	V3	V4	V5
V1	0	∞	13	2	13
V2	8	0	15	12	0
V3	9	∞	0	2	5
V4	14	∞	10	0	4
V5	3	6	12	∞	0

Langat, Vincent

	V1	V2	V3	V4	V5
V1	0	∞	7	10	7
V2	2	0	15	15	∞
V3	∞	2	0	7	8
V4	4	15	2	0	∞
V5	9	15	∞	5	0

Stewart, Jessica

	V1	V2	V3	V4	V5
V1	0	1	14	12	∞
V2	6	0	∞	11	1
V3	∞	10	0	9	5
V4	∞	9	15	0	4
V5	10	6	7	∞	0

Name: _____

J#: _____

Tchakoua, Astride

	V1	V2	V3	V4	V5
V1	0	5	4	∞	15
V2	∞	0	12	8	7
V3	3	10	0	1	∞
V4	6	6	∞	0	4
V5	8	∞	3	13	0

Washington, Daren

	V1	V2	V3	V4	V5
V1	0	∞	9	14	8
V2	7	0	∞	13	1
V3	10	13	0	∞	15
V4	7	3	1	0	∞
V5	12	9	6	∞	0

Wynn, Marcus

	V1	V2	V3	V4	V5
V1	0	3	2	∞	9
V2	∞	0	5	8	6
V3	9	6	0	∞	7
V4	∞	13	14	0	8
V5	3	2	∞	6	0

Jackson, Martice

	V1	V2	V3	V4	V5
V1	0	1	11	6	∞
V2	1	0	10	∞	12
V3	14	∞	0	10	6
V4	2	2	1	0	∞
V5	15	∞	3	15	0

	V1	V2	V3	V4	V5
V1	0	∞	8	9	9
V2	2	0	∞	4	13
V3	10	3	0	2	∞
V4	1	∞	1	0	5
V5	6	9	13	∞	0

	V1	V2	V3	V4	V5
V1	0	12	1	∞	13
V2	10	0	3	∞	15
V3	8	1	0	∞	1
V4	10	8	6	0	∞
V5	7	∞	6	8	0

	V1	V2	V3	V4	V5
V1	0	∞	9	14	8
V2	7	0	∞	13	1
V3	10	13	0	∞	15
V4	7	3	1	0	∞
V5	12	9	6	∞	0

	V1	V2	V3	V4	V5
V1	0	1	14	12	∞
V2	6	0	∞	11	1
V3	∞	10	0	9	5
V4	∞	9	15	0	4
V5	10	6	7	∞	0

	V1	V2	V3	V4	V5
V1	0	∞	8	4	10
V2	8	0	14	4	∞
V3	14	12	0	5	∞
V4	2	∞	13	0	2
V5	3	∞	12	13	0

	V1	V2	V3	V4	V5
V1	0	∞	2	4	11
V2	1	0	8	∞	1
V3	4	∞	0	8	3
V4	10	7	5	0	∞
V5	∞	15	10	9	0

Name: _____

J#: _____

Name: _____

J#: _____

Q4: 20 pts) For the edge weight matrix assigned to you for a directed graph, determine the shortest path weights from vertex V1 to every other vertex using the **Bellman-Ford algorithm**.

Show clearly the table (with the distance estimate and predecessor) for each iteration, as discussed in the slides.

Also, extract the shortest paths from V1 to every other vertex in the graph, as shown in the slides. Clearly show the path extraction steps.

Brown, Demetrius

	V1	V2	V3	V4	V5
V1	0	7	14	∞	3
V2	∞	0	9	3	1
V3	12	∞	0	10	9
V4	∞	9	10	0	12
V5	3	3	∞	4	0

Cato, Jahelle

	V1	V2	V3	V4	V5
V1	0	7	5	3	∞
V2	∞	0	4	12	14
V3	4	3	0	9	∞
V4	1	6	5	0	∞
V5	∞	3	11	9	0

Chukwuma, Nzefili

	V1	V2	V3	V4	V5
V1	0	∞	2	4	11
V2	1	0	8	∞	1
V3	4	∞	0	8	3
V4	10	7	5	0	∞
V5	∞	15	10	9	0

Clark, Armon

	V1	V2	V3	V4	V5
V1	0	1	11	∞	9
V2	10	0	9	∞	10
V3	∞	5	0	5	14
V4	14	∞	13	0	11
V5	8	12	13	∞	0

Collins, Taylor

	V1	V2	V3	V4	V5
V1	0	∞	8	4	10
V2	8	0	14	4	∞
V3	14	12	0	5	∞
V4	2	∞	13	0	2
V5	3	∞	12	13	0

Harmon, Alfred

	V1	V2	V3	V4	V5
V1	0	∞	13	2	13
V2	8	0	15	12	0
V3	9	∞	0	2	5
V4	14	∞	10	0	4
V5	3	6	12	∞	0

Langat, Vincent

	V1	V2	V3	V4	V5
V1	0	∞	7	10	7
V2	2	0	15	15	∞
V3	∞	2	0	7	8
V4	4	15	2	0	∞
V5	9	15	∞	5	0

Stewart, Jessica

	V1	V2	V3	V4	V5
V1	0	1	14	12	∞
V2	6	0	∞	11	1
V3	∞	10	0	9	5
V4	∞	9	15	0	4
V5	10	6	7	∞	0

Name: _____

J#: _____

Tchakoua, Astride

	V1	V2	V3	V4	V5
V1	0	5	4	∞	15
V2	∞	0	12	8	7
V3	3	10	0	1	∞
V4	6	6	∞	0	4
V5	8	∞	3	13	0

Washington, Daren

	V1	V2	V3	V4	V5
V1	0	∞	9	14	8
V2	7	0	∞	13	1
V3	10	13	0	∞	15
V4	7	3	1	0	∞
V5	12	9	6	∞	0

Wynn, Marcus

	V1	V2	V3	V4	V5
V1	0	3	2	∞	9
V2	∞	0	5	8	6
V3	9	6	0	∞	7
V4	∞	13	14	0	8
V5	3	2	∞	6	0

Jackson, Martice

	V1	V2	V3	V4	V5
V1	0	1	11	6	∞
V2	1	0	10	∞	12
V3	14	∞	0	10	6
V4	2	2	1	0	∞
V5	15	∞	3	15	0

	V1	V2	V3	V4	V5
V1	0	∞	8	9	9
V2	2	0	∞	4	13
V3	10	3	0	2	∞
V4	1	∞	1	0	5
V5	6	9	13	∞	0

	V1	V2	V3	V4	V5
V1	0	12	1	∞	13
V2	10	0	3	∞	15
V3	8	1	0	∞	1
V4	10	8	6	0	∞
V5	7	∞	6	8	0

	V1	V2	V3	V4	V5
V1	0	∞	9	14	8
V2	7	0	∞	13	1
V3	10	13	0	∞	15
V4	7	3	1	0	∞
V5	12	9	6	∞	0

	V1	V2	V3	V4	V5
V1	0	1	14	12	∞
V2	6	0	∞	11	1
V3	∞	10	0	9	5
V4	∞	9	15	0	4
V5	10	6	7	∞	0

	V1	V2	V3	V4	V5
V1	0	∞	8	4	10
V2	8	0	14	4	∞
V3	14	12	0	5	∞
V4	2	∞	13	0	2
V5	3	∞	12	13	0

	V1	V2	V3	V4	V5
V1	0	∞	2	4	11
V2	1	0	8	∞	1
V3	4	∞	0	8	3
V4	10	7	5	0	∞
V5	∞	15	10	9	0

Name: _____

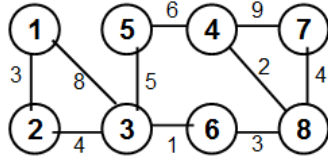
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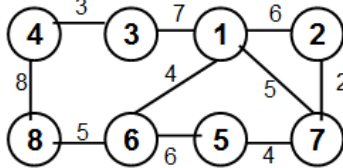
J#: _____

Q5: 20 pts) Run the **Dijkstra's shortest path algorithm** on the graph assigned to you, starting from Vertex 1, and determine the shortest path tree rooted from Vertex 1 to the rest of the vertices. If any edge does not have weight assigned, assume the weight of that edge to be 5. Show your work for each iteration in the skeletal graphs (see next page). For each skeletal graph, indicate the vertices and all the edges that are selected as part of the particular iteration as well as carried over from the previous iterations. Show all the steps.

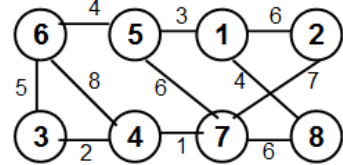
Brown, Demetrius



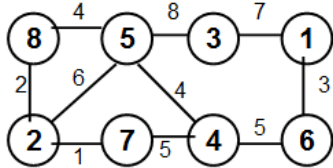
Cato, Jahelle



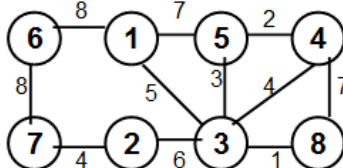
Chukwuma, Nzefili



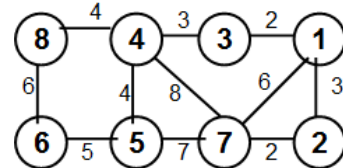
Clark, Armon



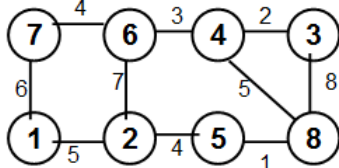
Collins, Taylor



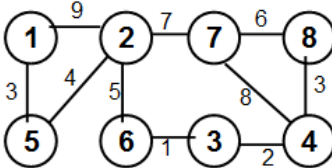
Harmon, Alfred



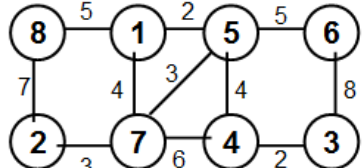
Langat, Vincent



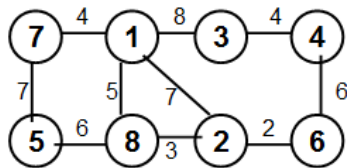
Stewart, Jessica



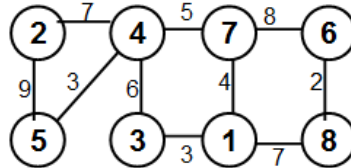
Tchakoua, Astride



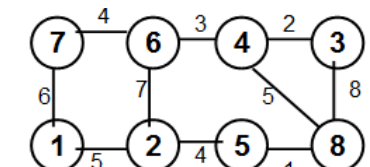
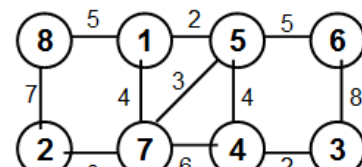
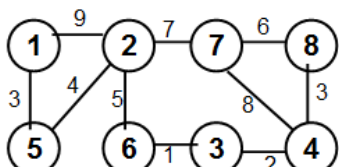
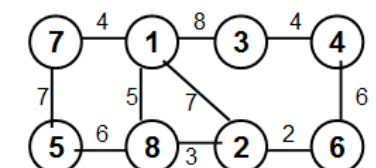
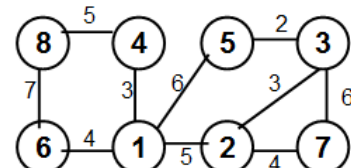
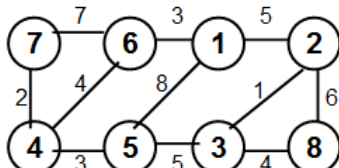
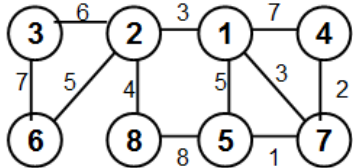
Washington, Daren



Wynn, Marcus



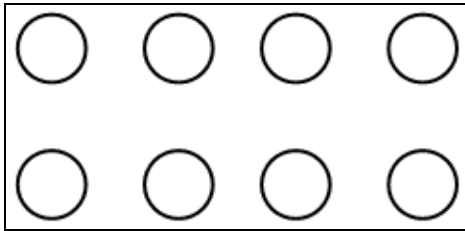
Jackson, Martice



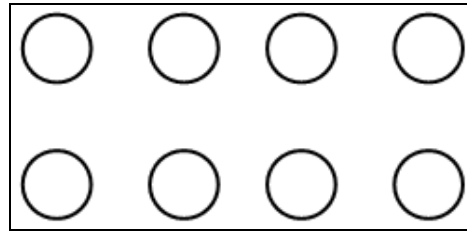
Name: _____

J#: _____

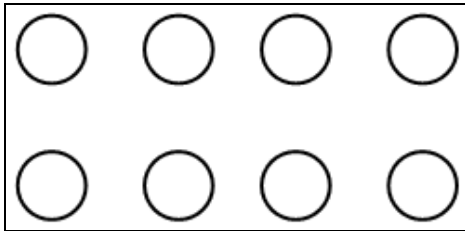
Skeletal Graphs (Iterations)



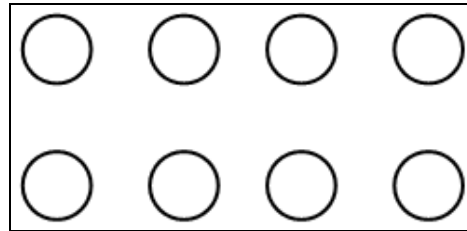
Given Graph



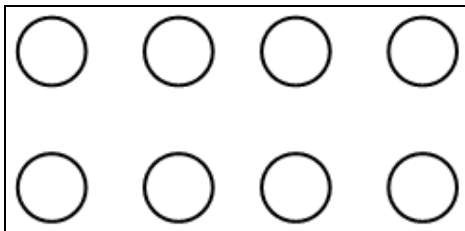
Initialization



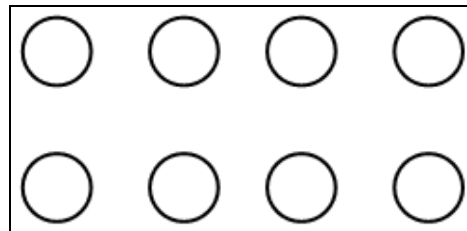
Iteration 1



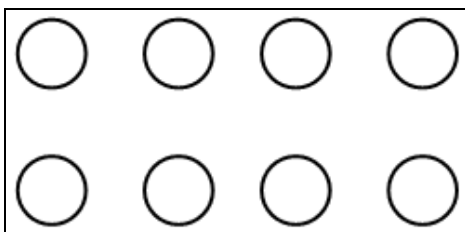
Iteration 2



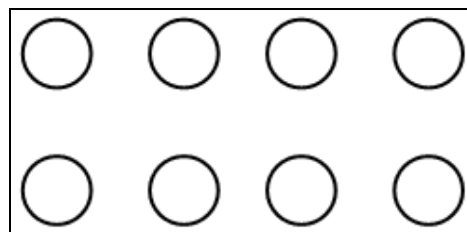
Iteration 3



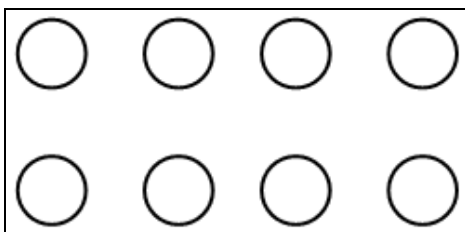
Iteration 4



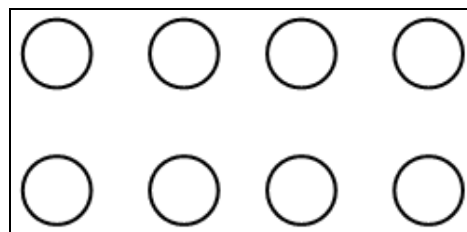
Iteration 5



Iteration 6



Iteration 7



Shortest Path Tree

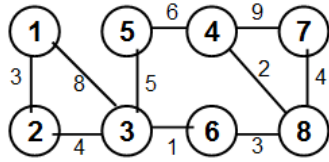
Sum of the Weights of the Shortest Path Tree: _____

Name: _____

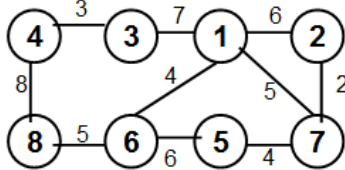
J#: _____

Q6: 15 pts) Run the Kruskal's algorithm for **maximum weight spanning tree** on the graph assigned to you. If any edge does not have weight assigned, assume the weight of that edge to be 5. Show your work for each iteration in the skeletal graphs (see next page). For each skeletal graph, indicate the vertices and all the edges that are selected as part of the particular iteration as well as carried over from the previous iterations. Show all the steps.

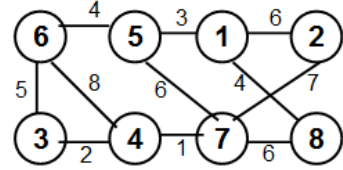
Brown, Demetrius



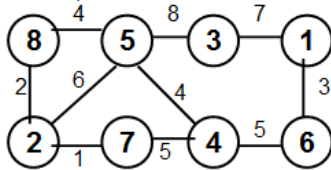
Cato, Jahelle



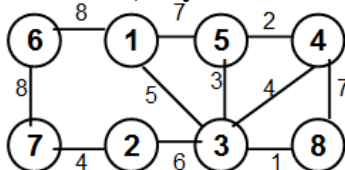
Chukwuma, Nzefili



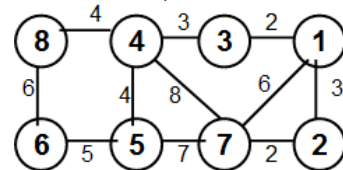
Clark, Armon



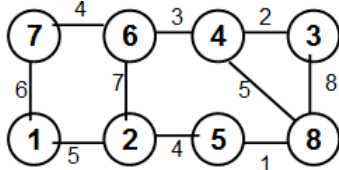
Collins, Taylor



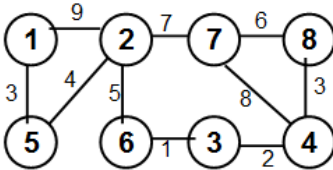
Harmon, Alfred



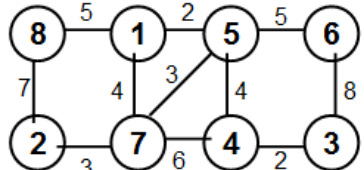
Langat, Vincent



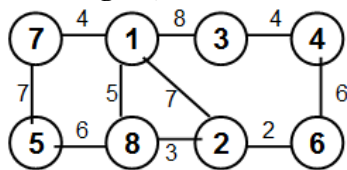
Stewart, Jessica



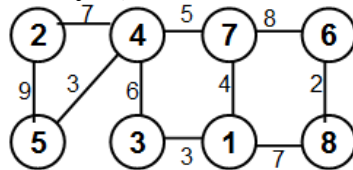
Tchakoua, Astride



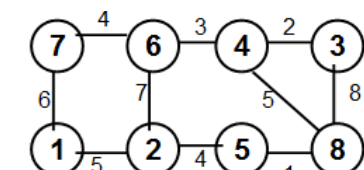
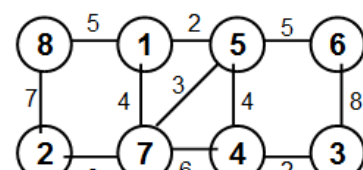
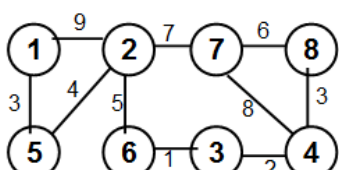
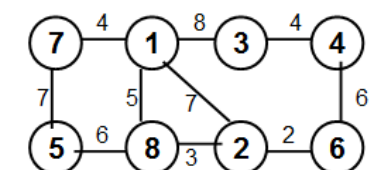
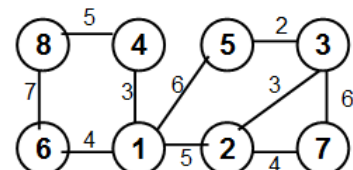
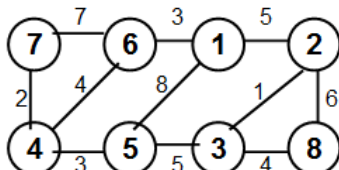
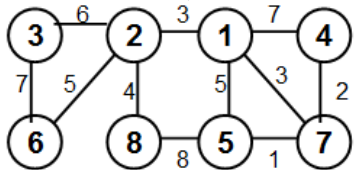
Washington, Daren



Wynn, Marcus



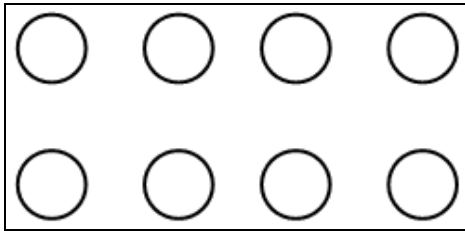
Jackson, Martice



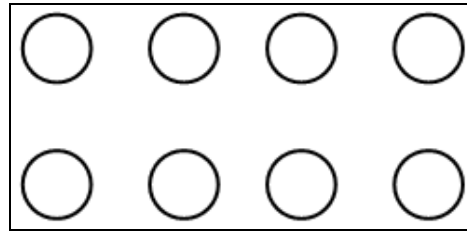
Name: _____

J#: _____

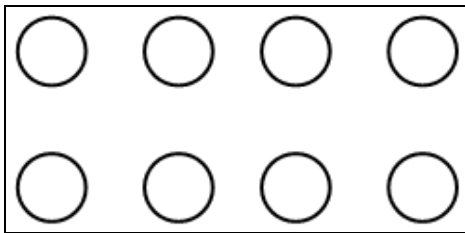
Skeletal Graphs (Iterations)



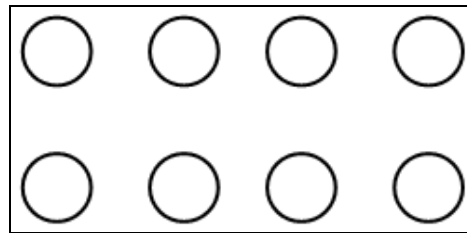
Given Graph



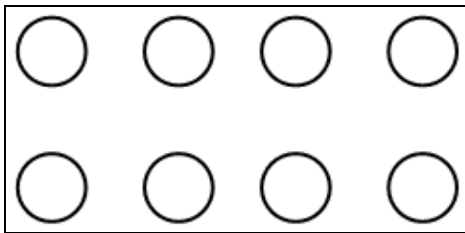
Initialization



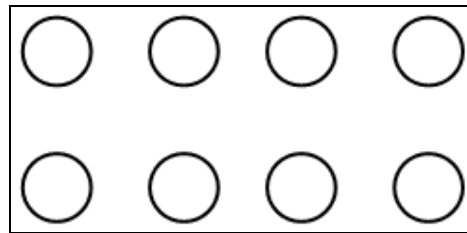
Iteration 1



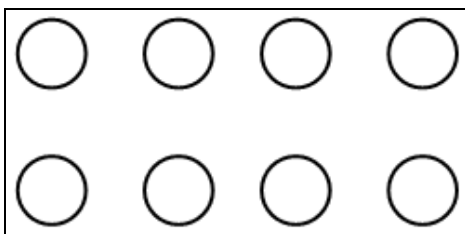
Iteration 2



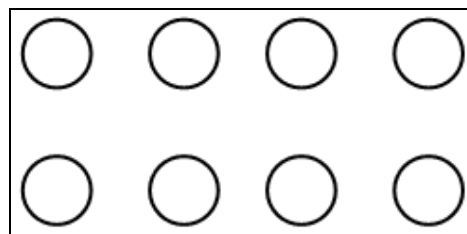
Iteration 3



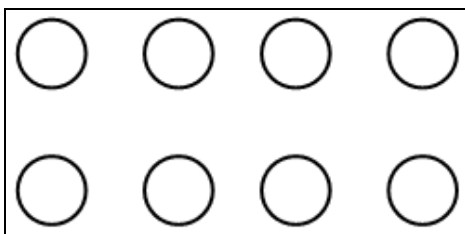
Iteration 4



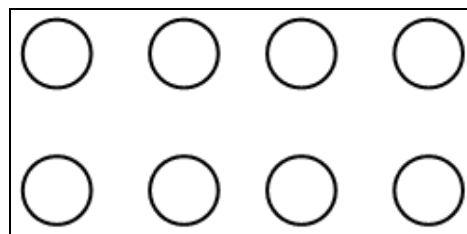
Iteration 5



Iteration 6



Iteration 7



Maximum Weight Spanning Tree

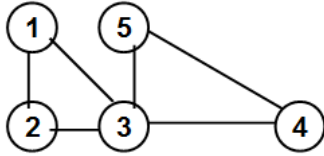
Sum of the weights of the Maximum Weight Spanning Tree: _____

Name: _____

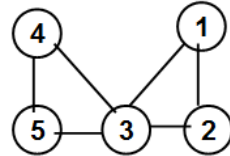
J#: _____

Q7: 15 pts) For the graph assigned below, use the **Transform and Conquer technique** (Matrix Multiplication) and compute the number of walks of length 4 between vertices 2 and 3.

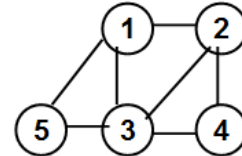
Brown, Demetrius



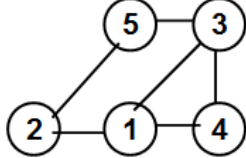
Cato, Jahelle



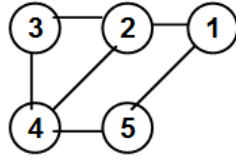
Chukwuma, Nzefili



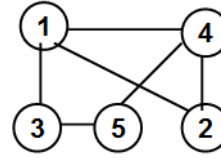
Clark, Armon



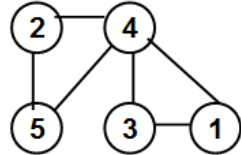
Collins, Taylor



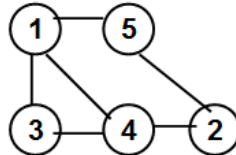
Harmon, Alfred



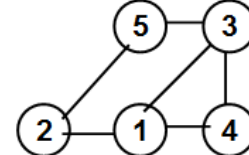
Langat, Vincent



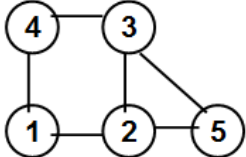
Stewart, Jessica



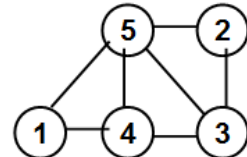
Tchakoua, Astride



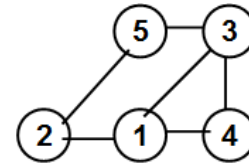
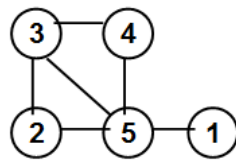
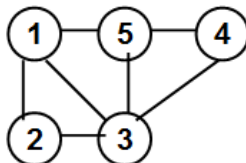
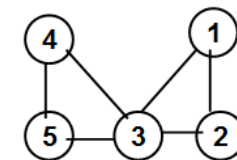
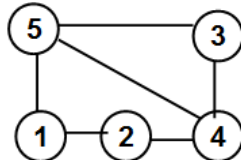
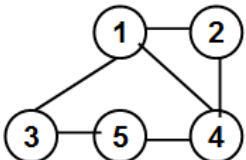
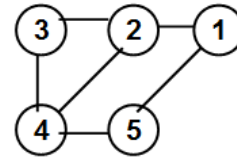
Washington, Daren



Wynn, Marcus



Jackson, Martice



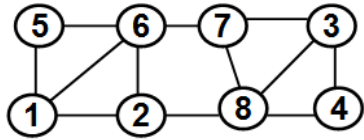
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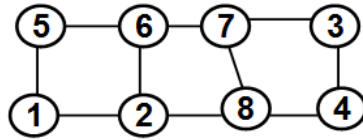
Name: _____

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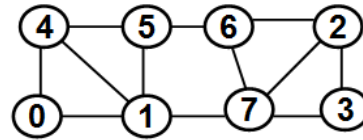
Q8) (20 pts) For the graph assigned to you, use the Breadth First Search algorithm-based approach to determine the BWC of a vertex with respect to the pair y and z: i.e., $BWC(X; Y \text{ and } Z)$.



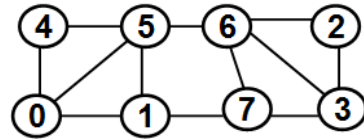
Brown, Demetrius



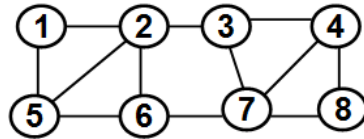
Cato, Jahelle



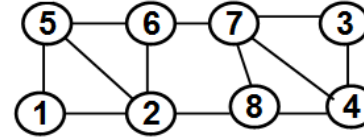
Chukwuma, Nzefili



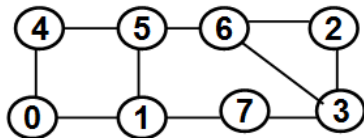
Clark, Armon



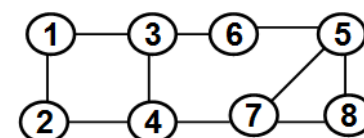
Collins, Taylor



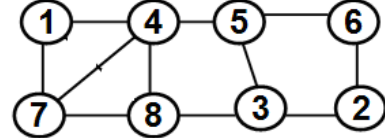
Harmon, Alfred



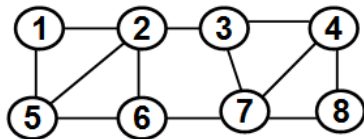
Langat, Vincent



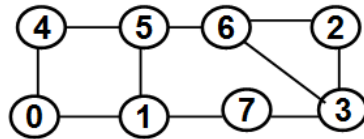
Stewart, Jessica



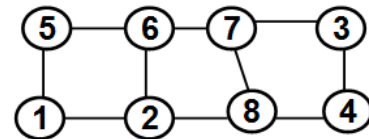
Tchakoua, Astride



Washington, Daren



Wynn, Marcus



Jackson, Martice

Student	X	Y and Z	Student	X	Y and Z
Brown, Demetrius	7	1 and 3	Harmon, Alfred	7	1 and 3
Cato, Jahelle	7	5 and 8	Langat, Vincent	7	0 and 2
Chukwuma, Nzefili	7	2 and 4	Stewart, Jessica	7	1 and 8
Clark, Armon	6	0 and 3	Tchakoua, Astride	5	1 and 2
Collins, Taylor	3	1 and 8	Washington, Daren	3	4 and 5
Wynn, Marcus	1	0 and 2	Jackson, Martice	7	1 and 3

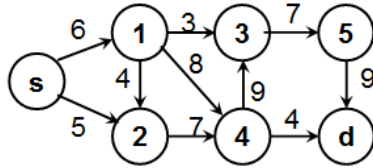
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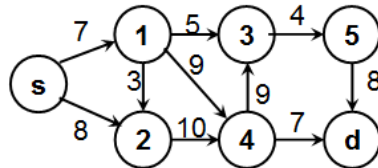
Name: _____

J#: _____

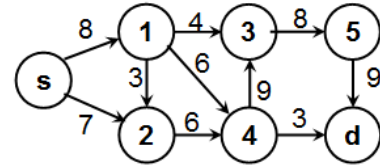
Q9) (20 pts) Run the Ford-Fulkerson algorithm on the graph assigned to you and determine the maximum flow possible between the source (s) and destination (d) as well as determine the minimum cut of edges (set of edges with the minimum sum of the edge weights) to disconnect the source and destination. Show all the work (including the use of the residual graphs in each iteration).



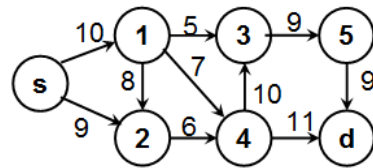
Brown, Demetrius



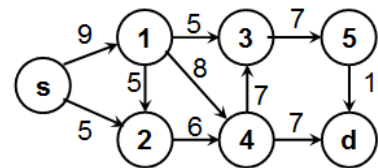
Cato, Jahelle



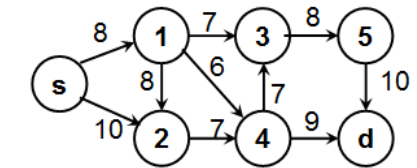
Chukwuma, Nzefili



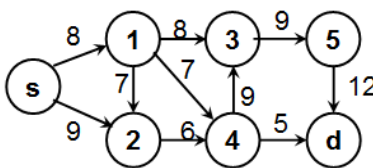
Clark, Armon



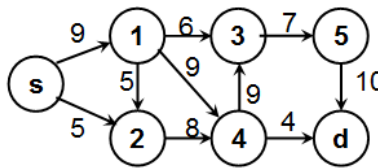
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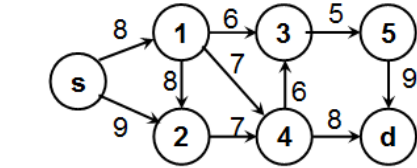
Harmon, Alfred



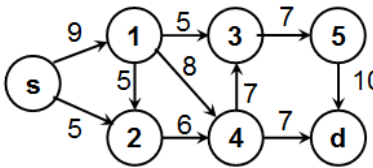
Langat, Vincent



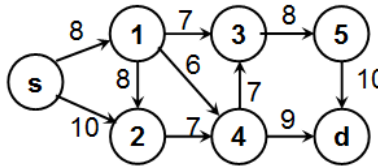
Stewart, Jessica



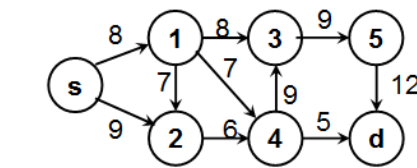
Tchakoua, Astride



Washington, Daren



Wynn, Marcus



Jackson, Martice

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J#: _____

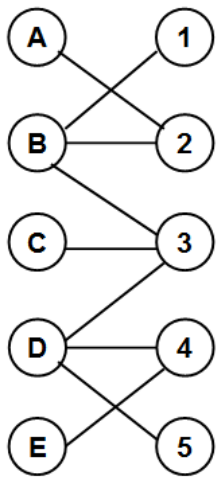
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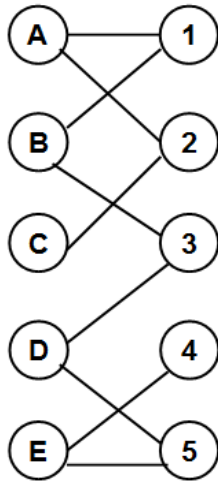
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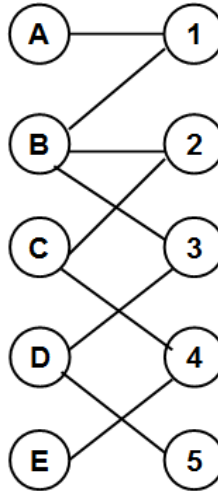
Q10) (15 pts) Use the Ford-Fulkerson algorithm to determine the maximum bipartite matching of the edges in the graph assigned to you. Show all the work.



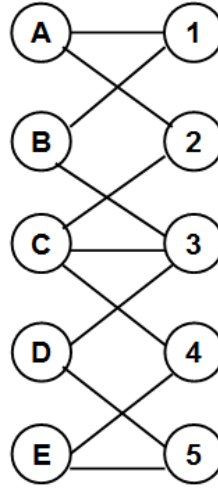
Demetrius, Brown



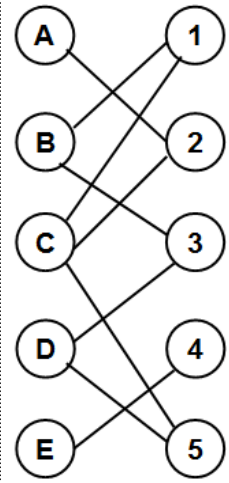
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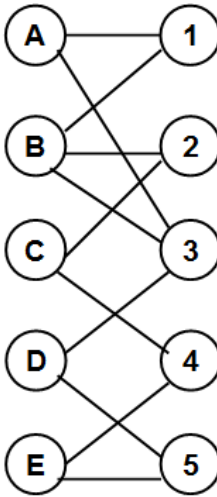
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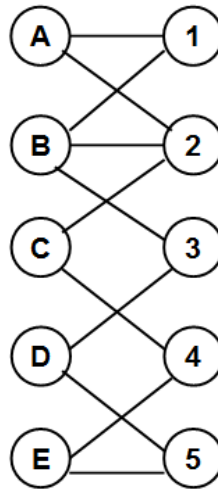
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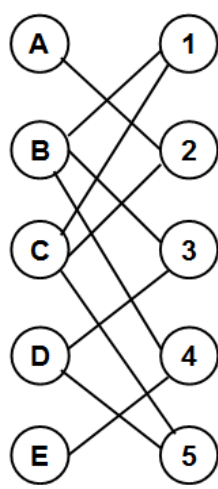
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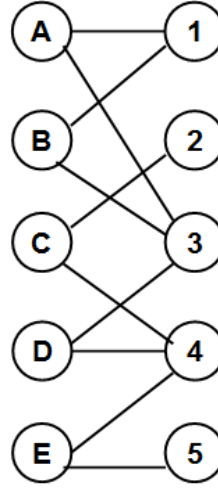
Harmon, Alfred



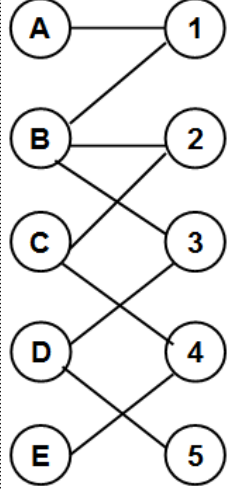
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Stewart, Jessica



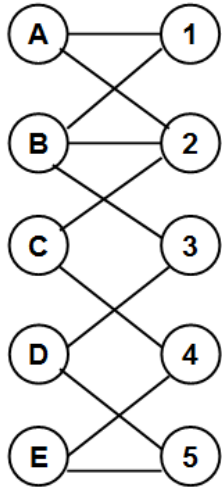
Tchakoua, Astride



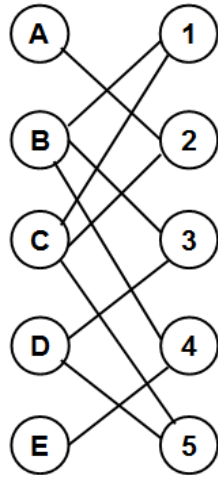
Jackson, Martice

Name: _____

J#: _____



Washington, Daren



Wynn, Marcus

Name: _____

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