

Jackson State University
CSC 323 Algorithm Design and Analysis, Spring 2018
Instructor: Dr. Natarajan Meghanathan
Exam 3 (Take Home)

Maximum Points: 200

Due on: April 24th, 2018: 1 PM

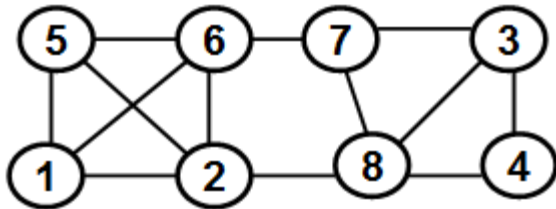
Print this exam and answer in the blank space/page provided after each question. You should staple your exam. Come to my office at ENB 275 and submit on-time at 1 PM

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

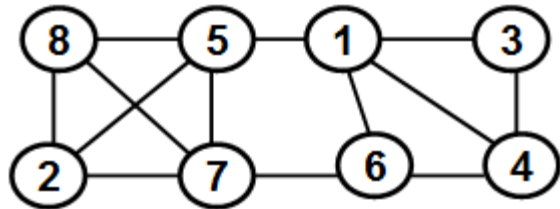
(a-7) Maximal Independent Set (b-2) Minimal Vertex Cover (c-8) Maximal Clique (d-8) Minimum Connected Dominating Set

Show all the work for each.

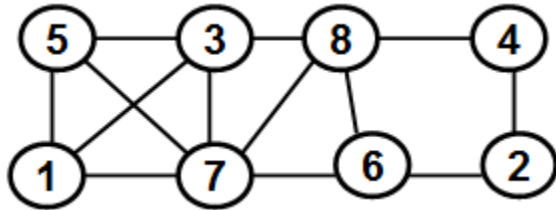
Leon Anderson



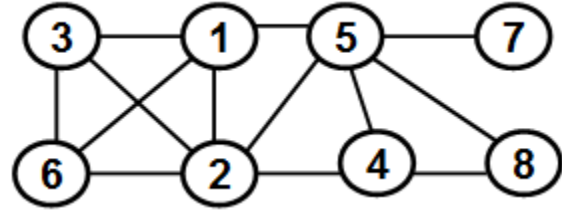
Ujjwal Baskota



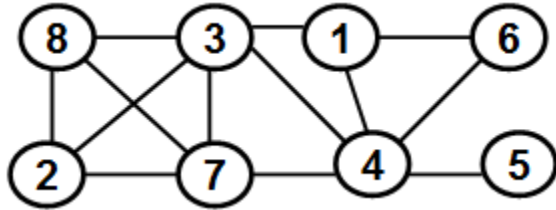
Albert Boateng



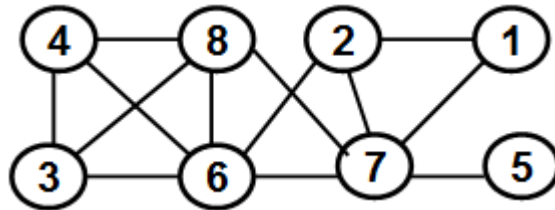
Samuel Dagne



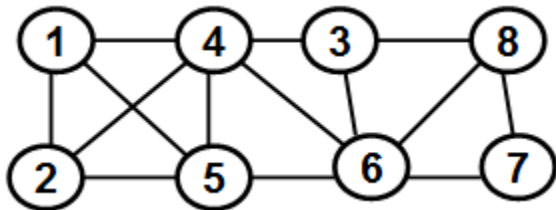
James Daniel



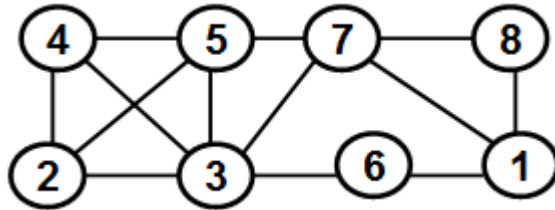
Zakeia Davis



Justin Epps



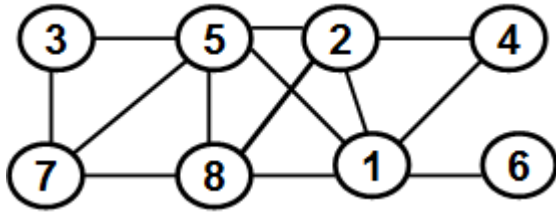
Amanuel Gebre



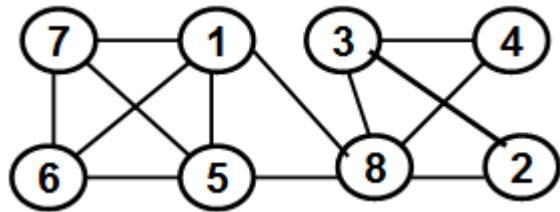
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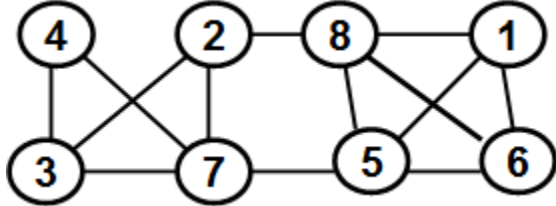
Melrondarius Groom



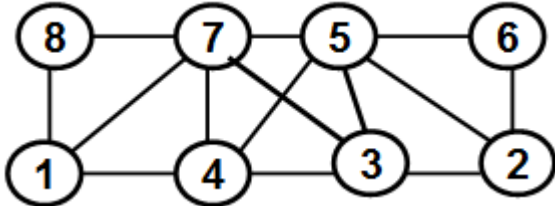
Yoseph Hailemariam



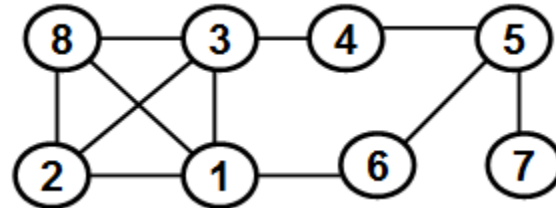
Antoine Hobson



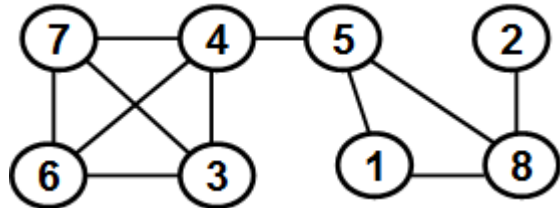
Portia Junius



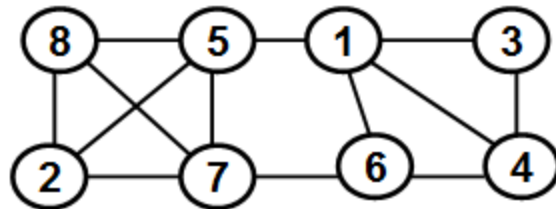
Justin McGuffee



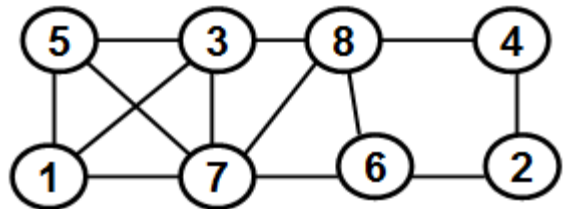
Ryun Moore



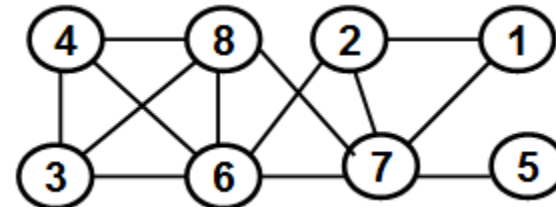
Keara Rogers



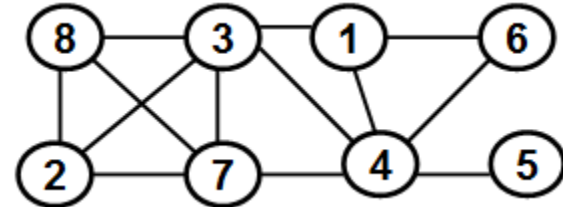
Timothy Stewart



Nebiyu Tadesse



Phat Tran



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Q2: 20 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.

Leon Anderson

	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

Ujjwal Baskota

	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

Albert Boateng

	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

Samuel Dagne

	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

James Daniel

	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

Zakeia Davis

	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

Justin Epps

	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

Amanuel Gebre

	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

Melrondarius Groom

	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

Yoseph Hailemariam

	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#: _____

Antoine Hobson

	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

Portia Junius

	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

Justin McGuffee

	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

Ryun Moore

	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

Keara Rogers

	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

Timothy Stewart

	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

Nebiyou Tadesse

	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

Phat Tran

	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.

Leon Anderson

	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

Ujjwal Baskota

	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

Albert Boateng

	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

Samuel Dagne

	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

James Daniel

	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

Zakeia Davis

	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

Justin Epps

	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

Amanuel Gebre

	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#: _____

Melrondarius Groom

	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

Yoseph Hailemariam

	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

Antoine Hobson

	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

Portia Junius

	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

Justin McGuffee

	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

Ryun Moore

	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

Keara Rogers

	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

Timothy Stewart

	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

Nebiyou Tadesse

	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

Phat Tran

	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: _____

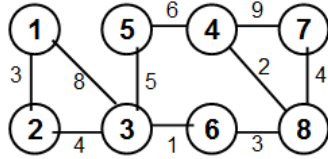
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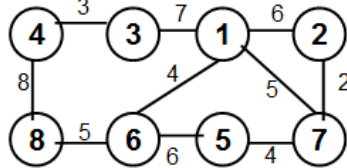
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Q4: 20 pts) Run the **Dijkstra's shortest path algorithm** on the graph assigned to you, starting from Vertex 1, and determine the shortest path tree rooted from Vertex 1 to the rest of the vertices. If any edge does not have weight assigned, assume 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.

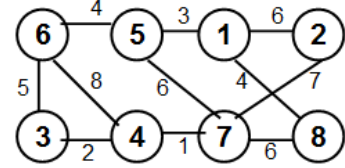
Leon Anderson



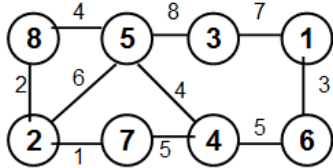
Ujjwal Baskota



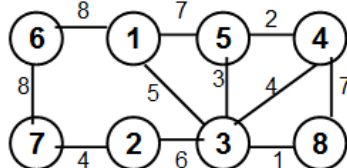
Albert Boateng



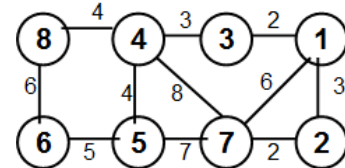
Samuel Dagne



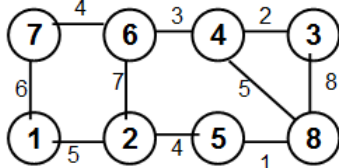
James Daniel



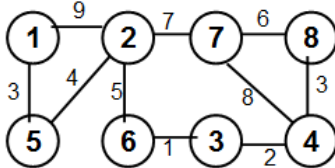
Zakeia Davis



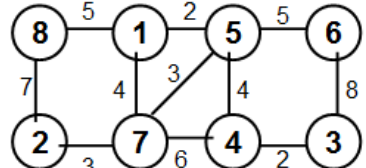
Justin Epps



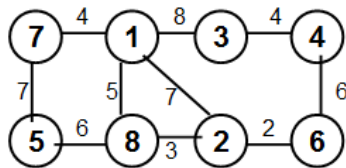
Amanuel Gebre



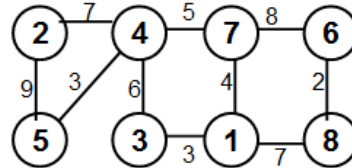
Melrondarius Groom



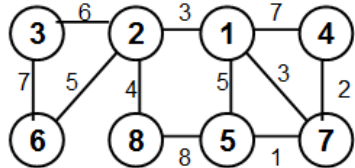
Yoseph Hailemariam



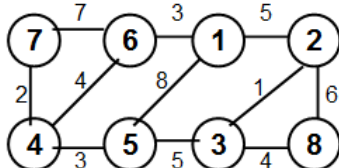
Antoine Hobson



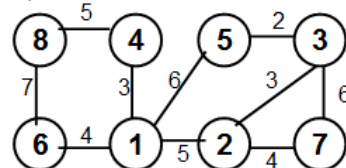
Portia Junius



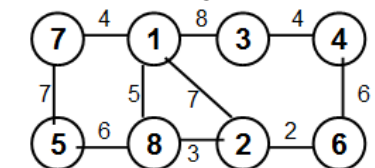
Justin McGuffee



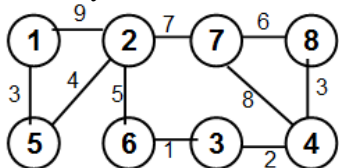
Ryun Moore



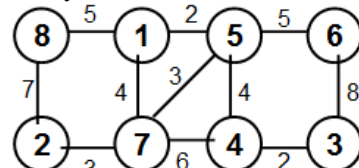
Keara Rogers



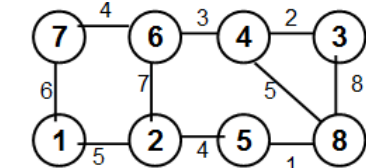
Timothy Stewart



Nebiyou Tadesse



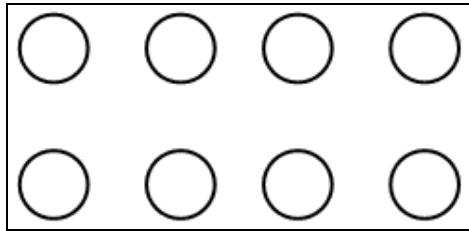
Phat Tran



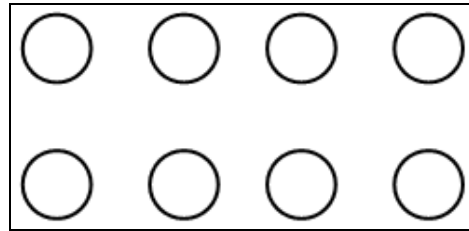
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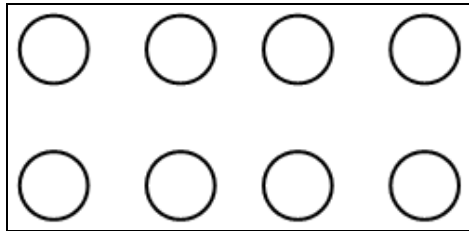
Skeletal Graphs (Iterations)



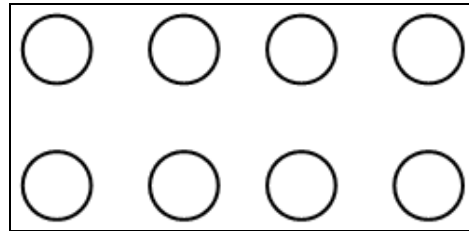
Given Graph



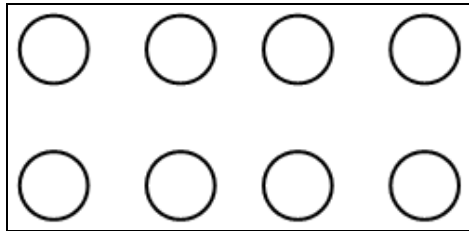
Initialization



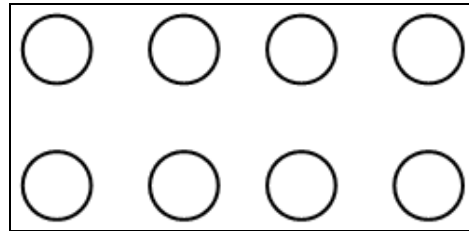
Iteration 1



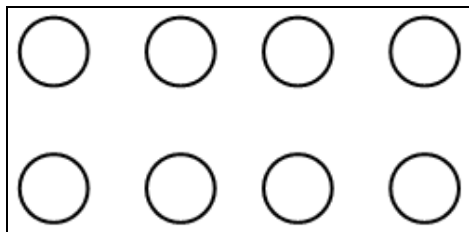
Iteration 2



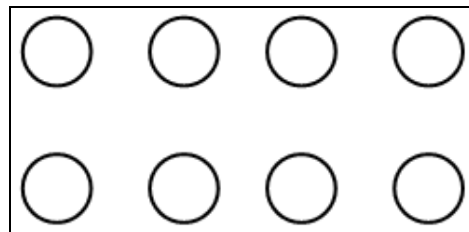
Iteration 3



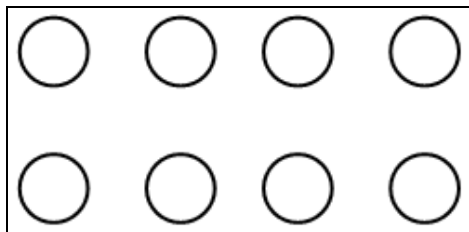
Iteration 4



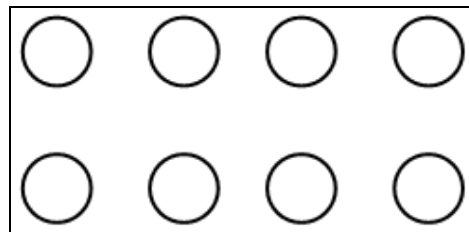
Iteration 5



Iteration 6



Iteration 7



Shortest Path Tree

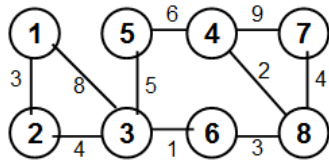
Sum of the Weights of the Shortest Path Tree: _____

Name: _____

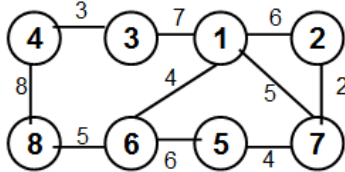
J#: _____

Q5: 15 pts) Run the Kruskal's algorithm for **minimum 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.

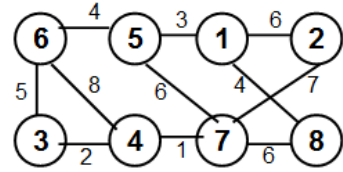
Leon Anderson



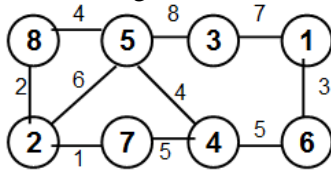
Ujjwal Baskota



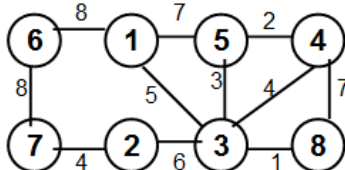
Albert Boateng



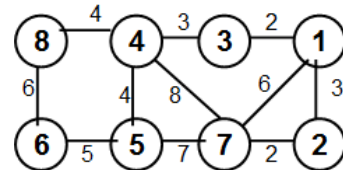
Samuel Dagne



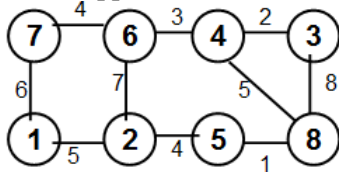
James Daniel



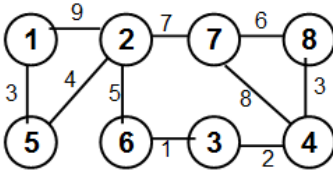
Zakeia Davis



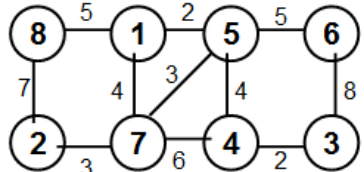
Justin Epps



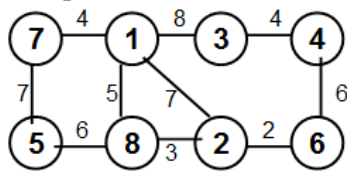
Amanuel Gebre



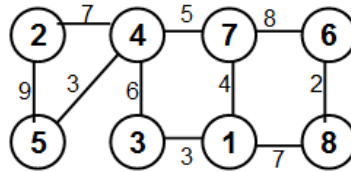
Melrondarius Groom



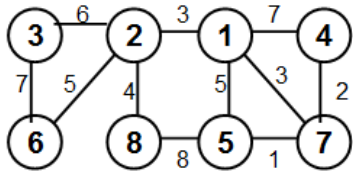
Yoseph Hailemariam



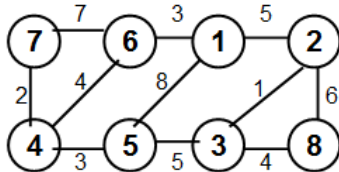
Antoine Hobson



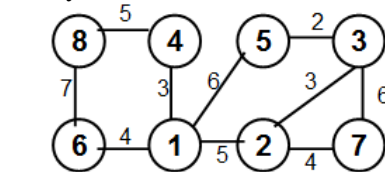
Portia Junius



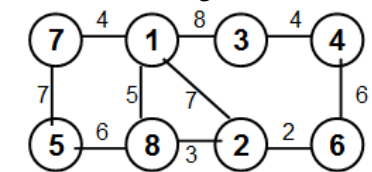
Justin McGuffee



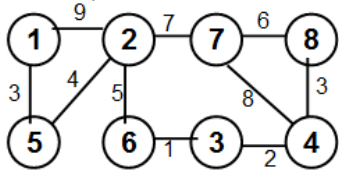
Ryun Moore



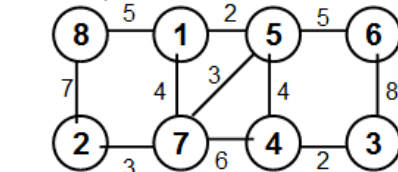
Keara Rogers



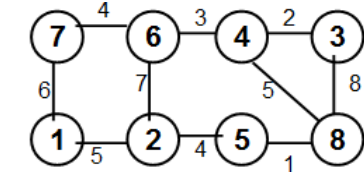
Timothy Stewart



Nebiyou Tadesse



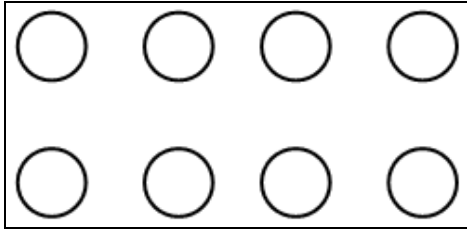
Phat Tran



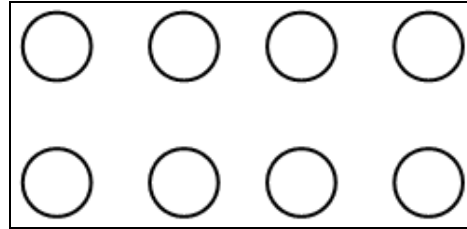
Name: _____

J#: _____

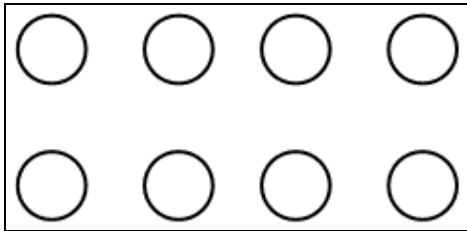
Skeletal Graphs (Iterations)



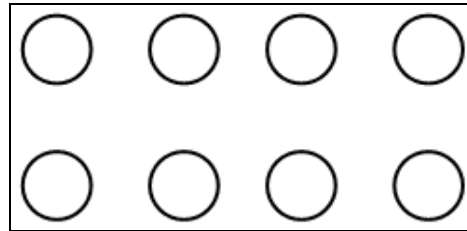
Given Graph



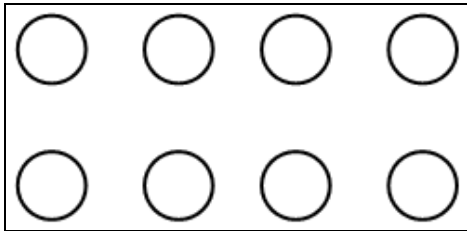
Initialization



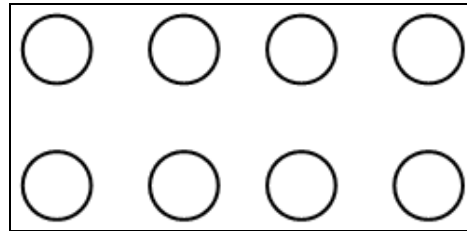
Iteration 1



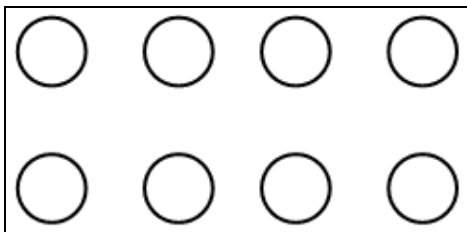
Iteration 2



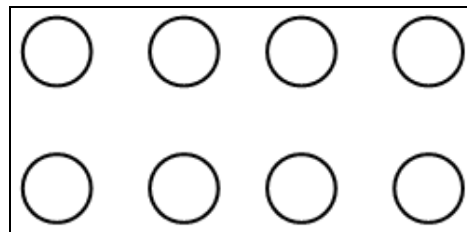
Iteration 3



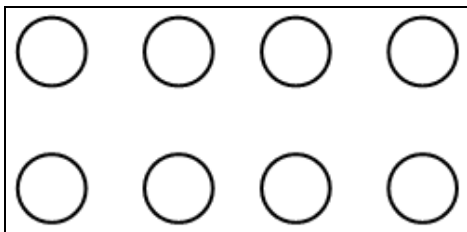
Iteration 4



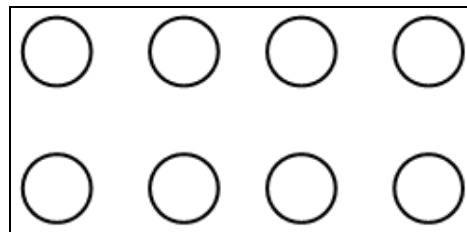
Iteration 5



Iteration 6



Iteration 7

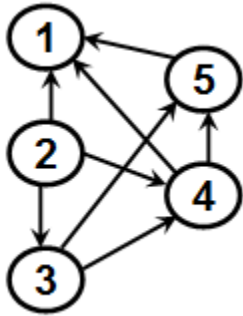


Minimum Weight Spanning Tree

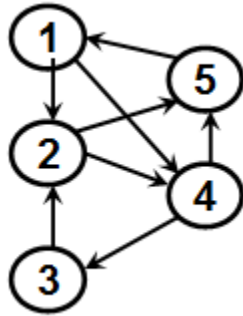
Sum of the weights of the Minimum Weight Spanning Tree: _____

Q6: 20 pts) For the directed graph assigned to you, run the **Depth First Search** algorithm.

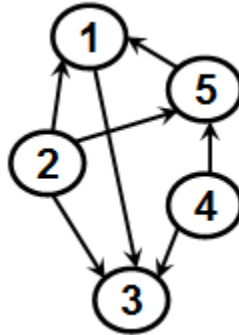
- (a) Clearly show the order in which the vertices are pushed and popped.
- (b) Clearly write the list of edges and their classification into one of the four categories as determined using DFS.
- (c) Determine whether the directed graph assigned to you is a DAG or not? If it is a DAG, write the topological sort of the vertices.



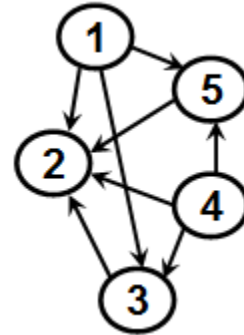
Leon Anderson



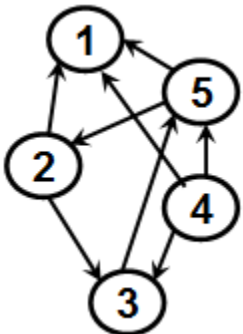
Ujjwal Baskota



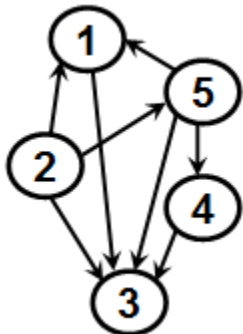
Albert Boateng



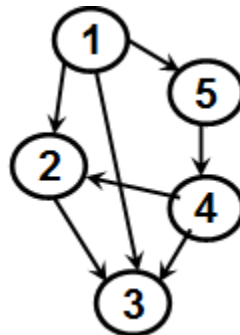
Samuel Dagne



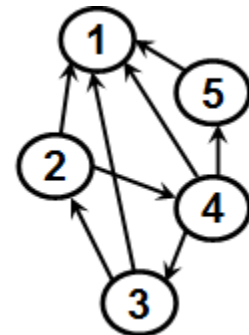
James Daniel



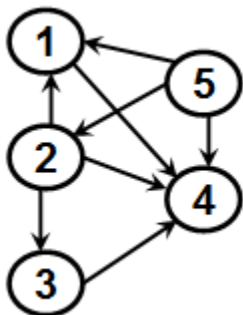
Zakeia Davis



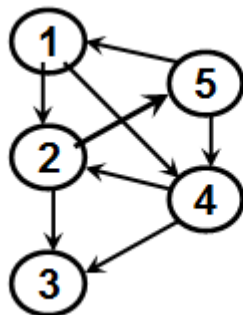
Justin Epps



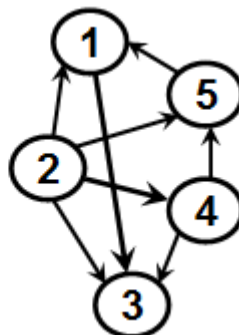
Amanuel Gebre



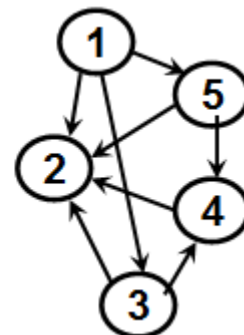
Melrondarius Groom



Yoseph Hailemariam



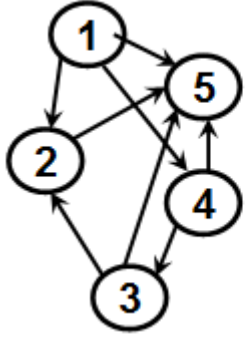
Antoine Hobson



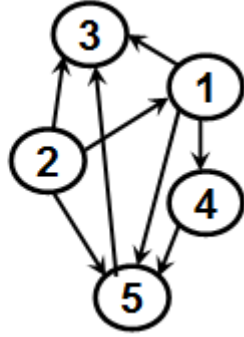
Portia Junius

Name: _____

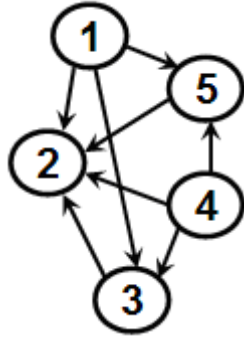
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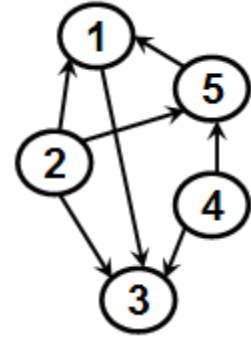
Justin McGuffee



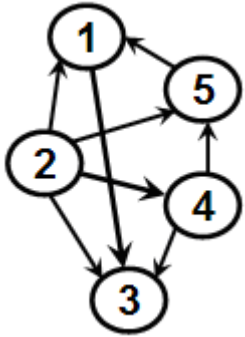
Ryun Moore



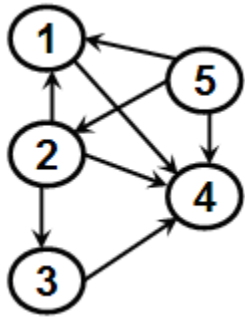
Keara Rogers



Timothy Stewart



Nebiyou Tadesse



Phat Tran

Name: _____

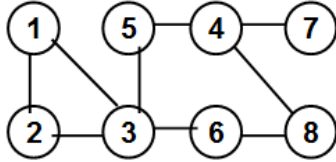
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Name: _____

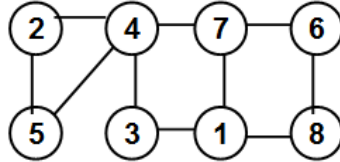
J#: _____

Q7: 20 pts) Conduct a **Depth First Search (DFS)** on the graph assigned to you. Clearly indicate the Tree edges and Back edges. Identify the articulation points. Show all the steps (incl. the order the vertices are visited). **Start your DFS from Vertex 1.**

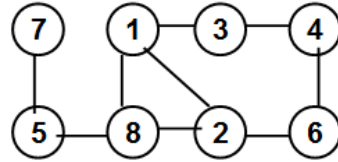
Leon Anderson



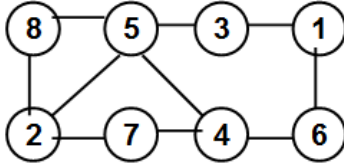
Ujjwal Baskota



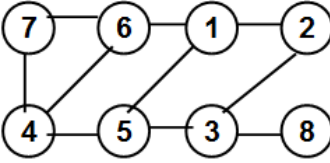
Nebiyou Tadesse



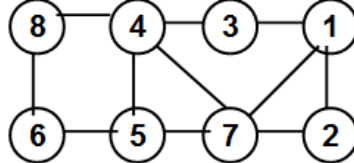
Albert Boateng



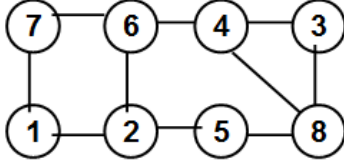
Samuel Dagne



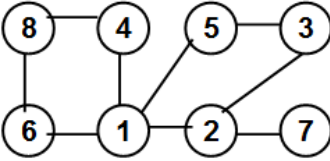
Keara Rogers



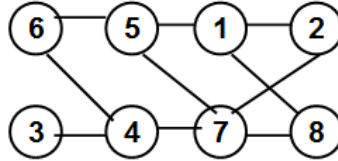
James Daniel



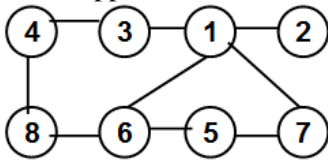
Zakeia Davis



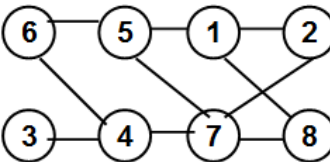
Timothy Stewart



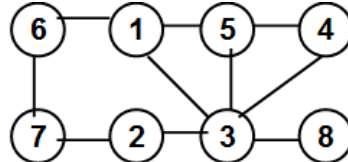
Justin Epps



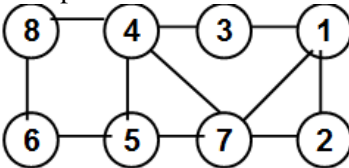
Amanuel Gebre



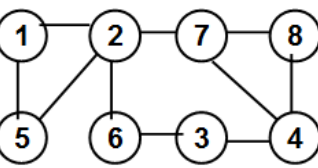
Melrondarius Groom



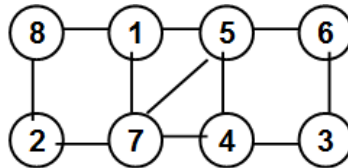
Yoseph Hailemariam



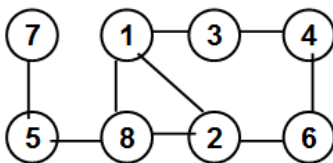
Antoine Hobson



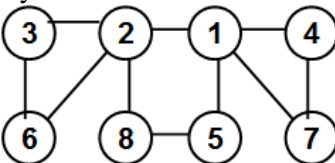
Portia Junius



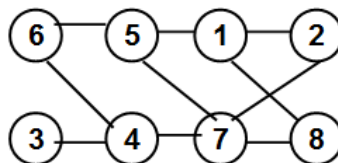
Justin McGuffee



Ryun Moore



Phat Tran



Name: _____

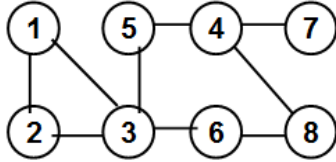
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Name: _____

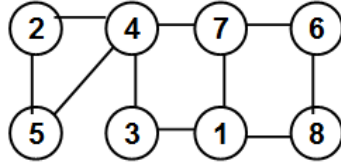
J#: _____

Q8: 15 pts) Conduct a **Breadth First Search (BFS)** on the graph assigned to you. Clearly indicate the Tree edges and Cross edges. **Start your BFS from Vertex 1.** Show the **distance (levels)** for the other vertices from the root. Also, Identify whether the given graph is **2-colorable or not**. Show all the steps.

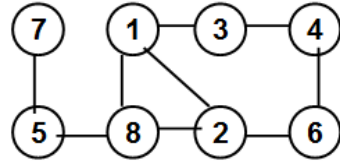
Leon Anderson



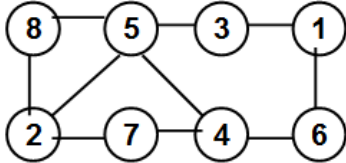
Ujjwal Baskota



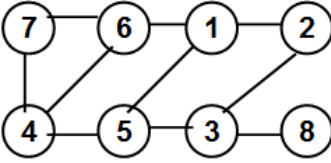
Nebiyou Tadesse



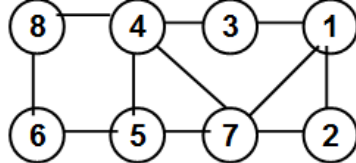
Albert Boateng



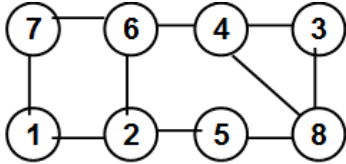
Samuel Dagne



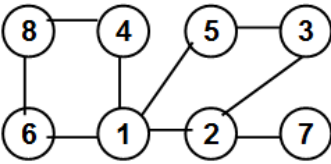
Keara Rogers



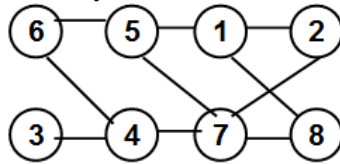
James Daniel



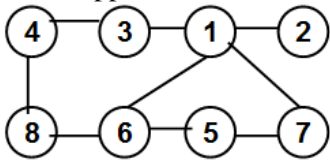
Zakeia Davis



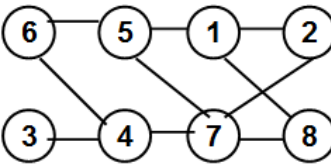
Timothy Stewart



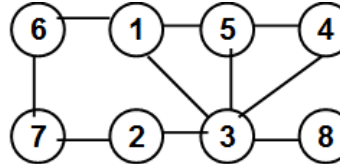
Justin Epps



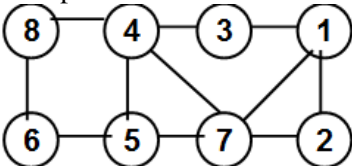
Amanuel Gebre



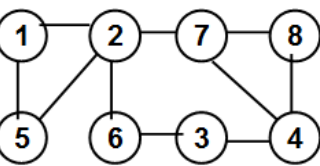
Melrondarius Groom



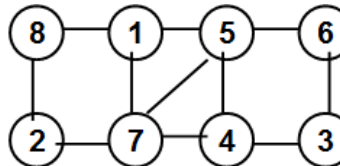
Yoseph Hailemariam



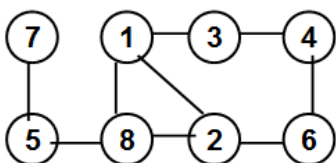
Antoine Hobson



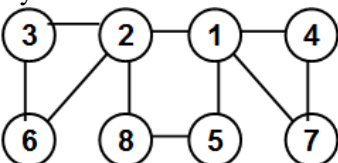
Portia Junius



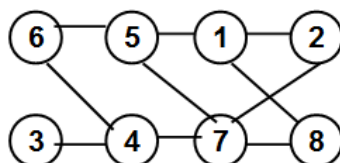
Justin McGuffee



Ryun Moore



Phat Tran



Name: _____

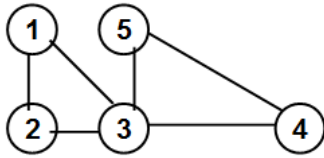
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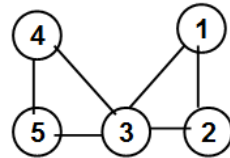
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Q9: 15 pts) For the graph assigned below, use the **Transform and Conquer technique** (Matrix Multiplication) and compute the number of walks of length 4 between vertices 2 and 3.

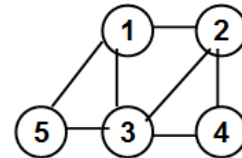
Leon Anderson



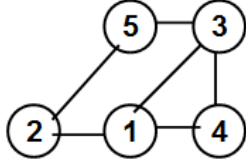
Ujjwal Baskota



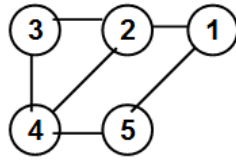
Nebiyou Tadesse



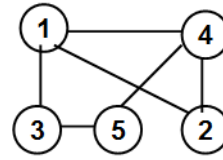
Albert Boateng



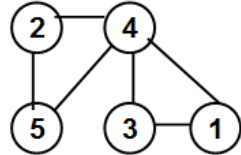
Samuel Dagne



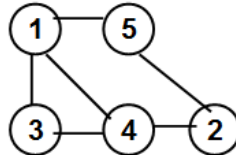
Keara Rogers



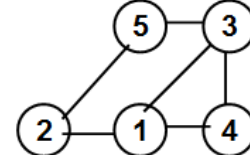
James Daniel



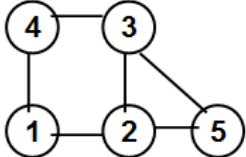
Zakeia Davis



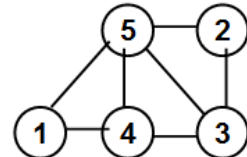
Timothy Stewart



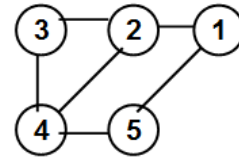
Justin Epps



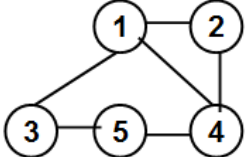
Amanuel Gebre



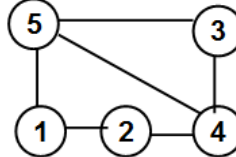
Melrondarius Groom



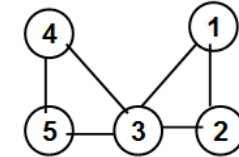
Yoseph Hailemariam



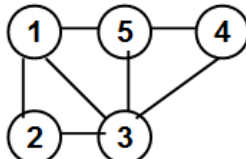
Antoine Hobson



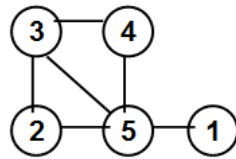
Portia Junius



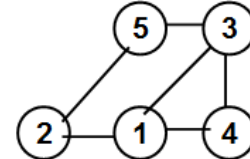
Justin McGuffee



Ryun Moore



Phat Tran



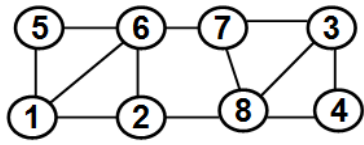
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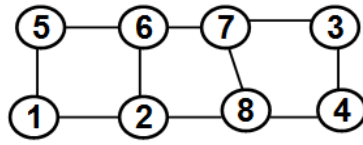
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J#: _____

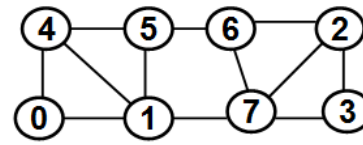
Q10: 25 pts) For the graph assigned to you, use the Breadth First Search algorithm-based approach to determine the **Betweenness Centrality (BWC)** of a vertex with respect to the pair y and z: i.e., $BWC(X; Y \text{ and } Z)$.



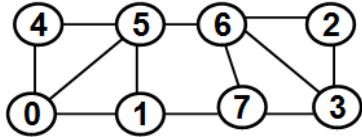
Leon Anderson



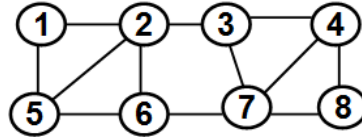
Ujjwal Baskota



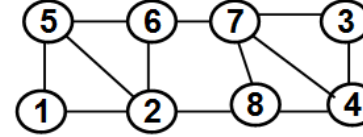
Nebiyou Tadesse



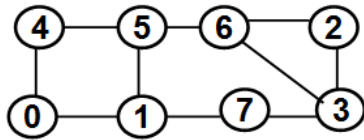
Albert Boateng



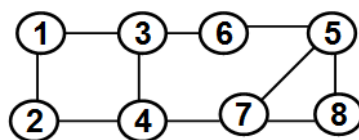
Samuel Dagne



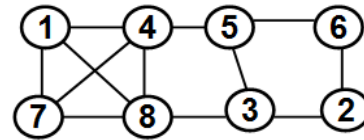
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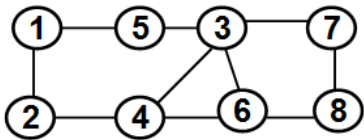
James Daniel



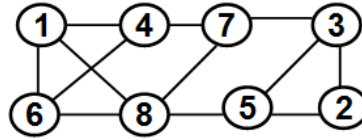
Zakeia Davis



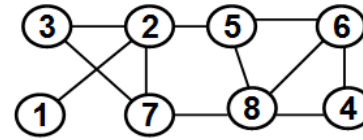
Timothy Stewart



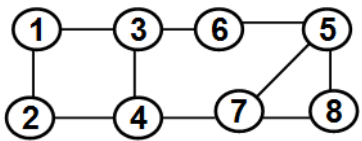
Justin Epps



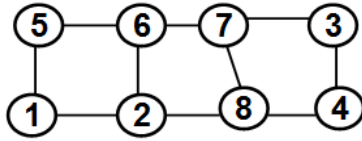
Amanuel Gebre



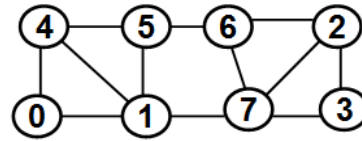
Melrondarius Groom



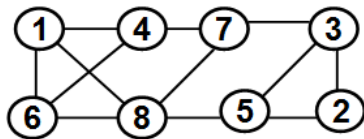
Yoseph Hailemariam



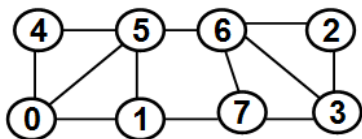
Antoine Hobson



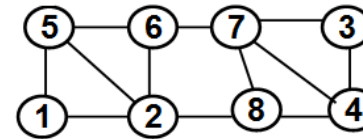
Portia Junius



Justin McGuffee



Ryun Moore



Phat Tran

Student	X	Y and Z	Student	X	Y and Z
Leon Anderson	7	1 and 3	Justin Epps	3	1 and 7
Ujjwal Baskota	8	4 and 5	Amanuel Gebre	7	1 and 3
Nebiyou Tadesse	1	0 and 2	Melrondarius Groom	7	1 and 8
Albert Boateng	6	0 and 2	Yoseph Hailemariam	7	1 and 8
Samuel Dagne	3	1 and 8	Antoine Hobson	6	1 and 3

Name: _____

J#: _____

Keara Rogers	2	4 and 5	Portia Junius	1	3 and 4
James Daniel	5	2 and 4	Justin McGuffee	7	1 and 3
Zakeia Davis	7	1 and 8	Ryun Moore	5	0 and 3
Timothy Stewart	3	1 and 2	Phat Tran	7	4 and 5

Name: _____

J#: _____