CSE 2320
Test 3
Spring 2018

Name Key 1
Your name as it appears on your UTA ID Card

Multiple Choice:

1. Write the letter or value for your answer on the line (_____) to the LEFT of each problem.
2. CIRCLED ANSWERS DO NOT COUNT.
3. 2 points each

1. For which graph representation is querying for the presence of an edge supported by binary search?

__D__ A. Adjacency lists (ordered)
B. Adjacency lists (unordered)
C. Adjacency matrix
D. Compressed adjacency lists (ordered)

2. For a double hash table with $\alpha = 0.9$ (without deletions), the upper bound on the expected number of probes for unsuccessful search is:

__10__

3. What is required when calling `union(i,j)` for maintaining disjoint subsets?

__A__ A. `i` and `j` are leaders for different subsets
B. `i` is the ancestor of `j` in one of the trees
C. `i` and `j` are leaders for the same subset
D. `i` and `j` are in the same subset

4. Suppose a depth-first search on a directed graph yields a path of tree edges from vertex X to vertex Y and a path of tree edges from vertex X to Z. If there is also an edge from Z to X, then its type will be:

__A__ A. Back
B. Cross
C. Forward
D. Tree

5. The cycle property for minimum spanning trees may be used to find an MST by:

__C__ A. Growing the MST by repeatedly including a maximum weight edge from some vertex in the tree to some vertex that has not yet been placed in the tree.
B. Growing the MST by repeatedly including a minimum weight edge from some vertex in the tree to some vertex that has not yet been placed in the tree.
C. Remove the maximum weight in any cycle until only a tree of edges remains.
D. Remove the minimum weight in any cycle until only a tree of edges remains.

6. The capacity of any cut is:

__A__ A. An upper bound on the maximum flow.
B. The same as the capacity of all other cuts.
C. The same as the maximum attainable flow.
D. A lower bound on the maximum flow.

7. Suppose a directed graph has a path from vertex X to vertex Y, but no path from vertex Y to vertex X. The relationship between the finish times for depth-first search is:

A

A. finish(X) > finish(Y)
B. finish(X) < finish(Y)
C. finish(X) = finish(Y)
D. could be either A. or B.

8. Suppose an instance of bipartite matching has 5 vertices in the left column, 8 vertices in the right column, and 17 edges. The number of edges in the corresponding instance of network flow is:

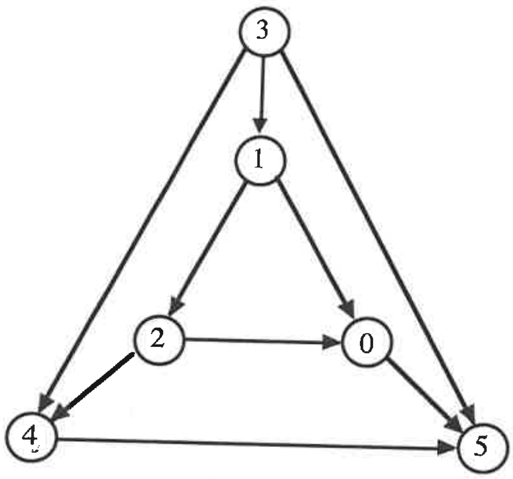
30

9. The relationship of the net flow across a cut and the amount of flow from the source to the sink is:

C

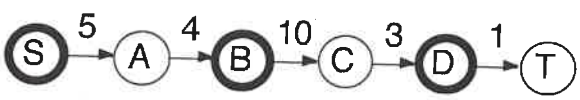
A. The net flow does not exceed the amount of flow.
B. There is no relationship.
C. They are equal.
D. The amount of flow does not exceed the net flow.

10. What is the number of strongly connected components in this graph?



6

11. The capacity of the following cut is ______. (S vertices are bold.)



16

12. A topological ordering of a directed graph may be computed by:

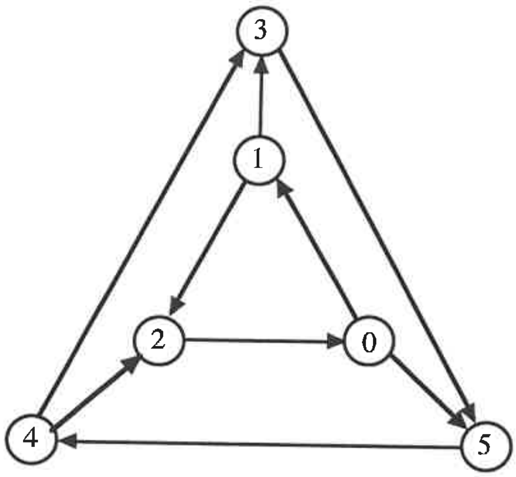
A

A. Ordering the vertices by descending finish time after DFS
B. Ordering the vertices by ascending discovery time after DFS
C. Ordering the vertices by ascending finish time after DFS
D. Ordering the vertices by descending discovery time after DFS

13. During a breadth-first search, the status of a gray vertex is:

__B__ A. It has been completely processed. B. It is in the FIFO queue.
C. It is in the priority queue. D. It is undiscovered.

14. What is the number of strongly connected components in this graph?



__1__

15. The worst-case time for Dijkstra's algorithm implemented with a minheap is:

__B__ A. $\Theta(V + E)$ B. $\Theta(E \log V)$ C. $\Theta(V \log V)$ D. $\Theta(V \log E)$

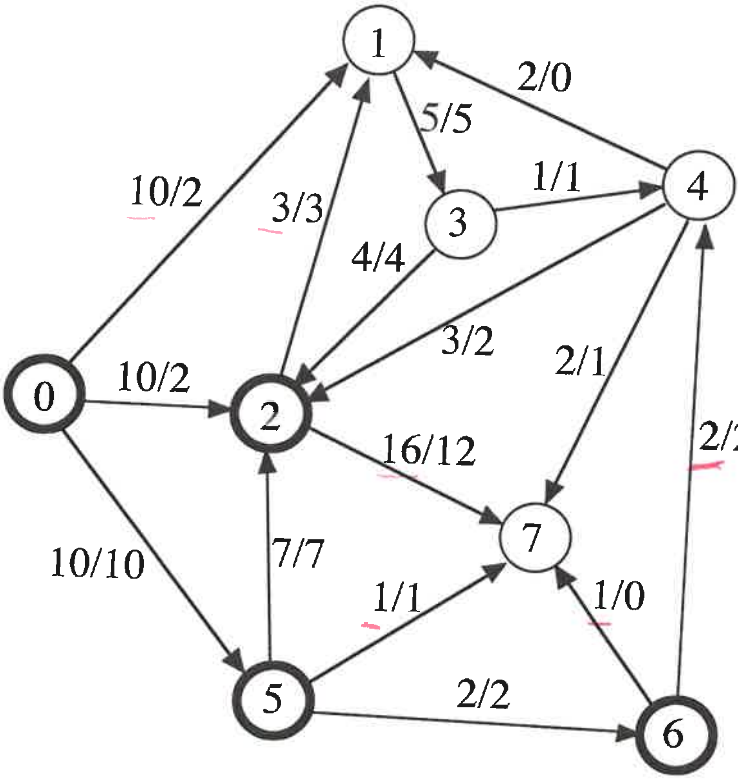
16. When using two breadth-first searches to find the diameter of a tree, the purpose of the first search is to find:

__A__ A. one end of a diameter. B. the number of edges in the diameter.
C. all vertices that could be an end of a diameter. D. both ends of a diameter.

17. In Dijkstra's algorithm, the final shortest path distance from the source s to a vertex x is known when:

__D__ A. x is placed on the heap.
B. x is read from the input file.
C. some vertex y moves from T to S and there is an edge from y to x.
D. x has its entry extracted from the heap.

Problems 18, 19, and 20 refer to the following network. 0 is the source. 7 is the sink. Each edge is labeled with capacity/flow.



18. The capacity of the indicated cut (S vertices are bold) is:

~~34~~ 33

19. The net flow across the given cut is:

14

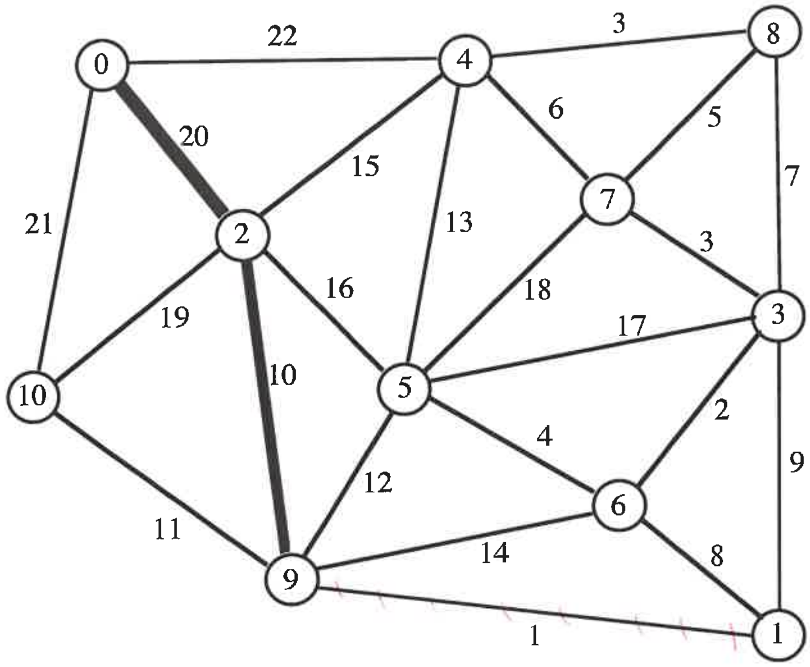
20. Suppose the flow is increased as much as possible using the augmenting path $0 \rightarrow 2 \rightarrow 4 \rightarrow 7$. Which is the critical edge?

B

A. $2 \rightarrow 4$ B. $4 \rightarrow 7$ C. $0 \rightarrow 2$ D. Insufficient information

Long Answer

1. What are the entries in the T-table (for Prim's algorithm) before and after moving the next vertex and edge into the minimum spanning tree? DO NOT COMPLETE THE ENTIRE MST!!! Edges already in the MST are the thick ones. Edges currently not in the MST are the narrow ones. 10 points.



Before

1	1(9)
3	∞
4	15(2)
5	12(9)
6	14(9)
7	∞
8	∞
10	11(9)

After

3	9(1)
4	15(2)
5	12(9)
6	8(1)
7	∞
8	∞
10	11(9)

2. Consider the following hash table whose keys were stored by double hashing using $h_1(key) = key \% 17$ and $h_2(key) = 1 + (key \% 16)$.

0	-1
1	800
2	-1
3	-1
4	701
5	-1
6	601
7	-1
8	501
9	-1
10	401
11	-1
12	301
13	-1
14	201
15	-1
16	101

a. Suppose 2001 is to be inserted (using double hashing). Which slot will be used? (5 points)

12 = h1

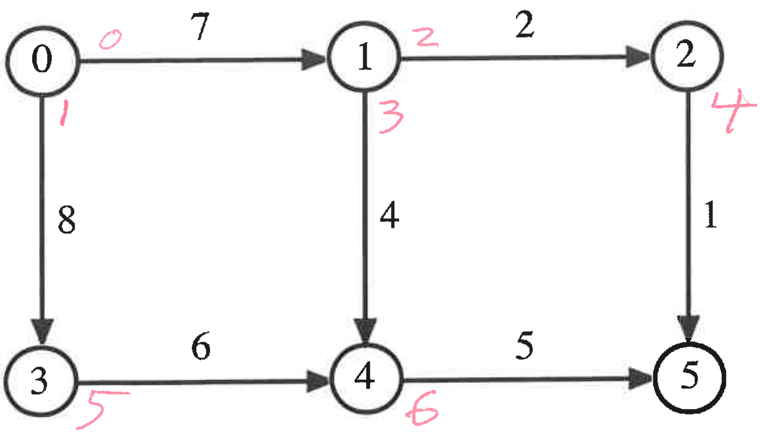
1+1=2=h2

12, 14, 16, 1, 3

b. Suppose 2002 is to be inserted (using double hashing) *after* 2001 has been stored. Which slot will be used? (5 points)

13 = h1

3. Show the ***compressed*** adjacency list representation for this weighted, directed graph. (Answers using conventional adjacency lists will receive no credit.) 10 points.



tail	Tab
0	0
1	2
2	4
3	5
4	6
5	7
6	7

headTab	head	Weight
0	1	7
1	3	8
2	2	2
3	4	4
4	5	1
5	4	6
6	5	5

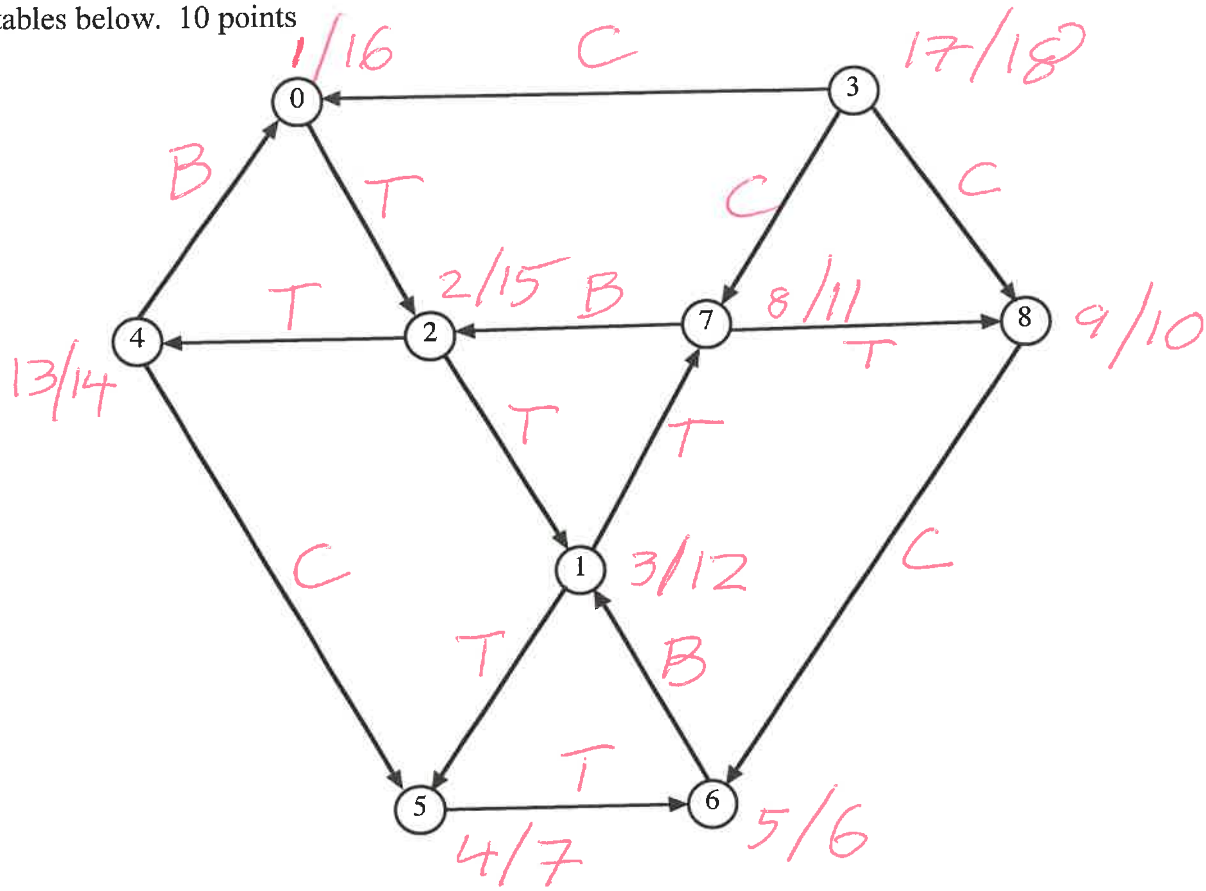
4

	0		1		2		3		4	
0	11	2	9	2	3	2	8	2	4	4
1	17	4	15	4	9	4	12	3	4	4
2	8	0	6	1	11	0	5	3	10	1
3	15	0	24	0	18	0	23	0	19	0
4	13	2	11	2	5	2	10	2	15	2

4. Demonstrate the Floyd-Warshall algorithm, ***with successors***, for the following input adjacency matrix. (999 represents infinity) The paths indicated in the final matrix must have ***at least one*** edge. You ***are not*** required to show the intermediate matrices. 10 points.

	0	1	2	3	4
0	999	999	3	999	4
1	999	999	11	12	4
2	8	6	999	5	999
3	15	999	20	999	999
4	999	999	5	999	999

5. Perform depth-first search on the following graph, including start/finish times and edge types (T=tree, B=back, C=cross, F=forward.) Assume that the adjacency lists are **ordered**. Write your answer in the tables below. 10 points

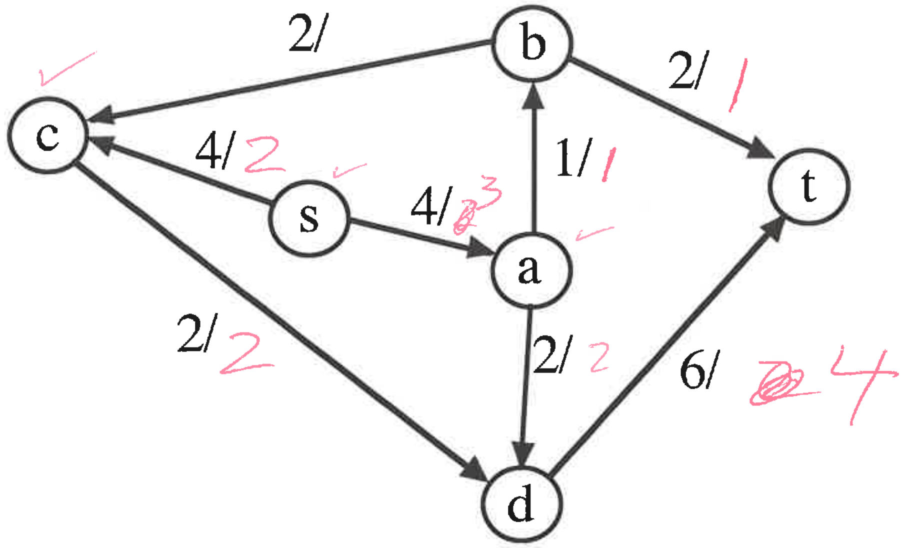


Vertex	Start	Finish
0	1	16
1	3	12
2	2	15
3	17	18
4	13	14
5	4	7
6	5	6
7	8	11
8	9	10

Edge	Type
0 2	T
1 5	T
1 7	T
2 1	T
2 4	T
3 0	C
3 7	C
3 8	C
4 0	B

Edge	Type
4 5	C
5 6	T
6 1	B
7 2	B
7 8	T
8 6	C

6. Give augmenting paths for determining a maximum flow and give a minimum cut for the following network. s is the source and t is the sink. 10 points.



Minimum Cut:

S vertices: s s a c

T vertices: t t b d

Augmenting Paths and Contribution to Flow:

s, a, d, t / 2

s, a, b, t / 1

s, c, d, t / 2

Σ = 5