CSE 3318-004
Test 3
Fall 2020

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

Multiple Choice:

1. Write the letter or value of 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?

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

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:

A
A. Remove the maximum weight edge in any cycle until only a tree of edges remains.
B. 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.
C. 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.
D. Remove the minimum weight edge in any cycle until only a tree of edges remains.

6. Which algorithm maintains multiple subtrees?

B
A. Dijkstra's
B. Kruskal's
C. Prim's
D. Warshall's

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:

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

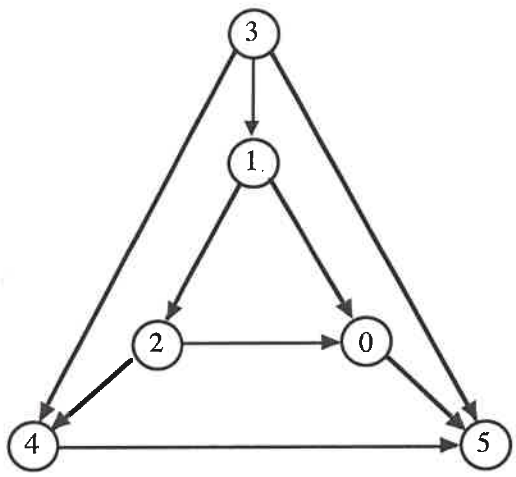
8. Which edge is chosen in a phase of Kruskal's algorithm?

D
A. The unprocessed edge (x, y) of smallest weight such that `find(x)==find(y)`
B. An edge of maximum-weight in a cycle (to be excluded)
C. An edge that is on a shortest path from the source
D. The unprocessed edge (x, y) of smallest weight such that `find(x)!=find(y)`

9. Which of the following cannot occur when additional edges are included in a directed graph?

B
A. The number of strong components may remain the same.
B. The number of strong components may increase.
C. The number of strong components may decrease.
D. The graph acquires a cycle.

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



6

11. Suppose the compressed adjacency list representation is used for a directed graph with n vertices and m edges. The value stored at the last entry of the tailTab is:

C
A. n B. $n+1$ C. m D. $m+1$

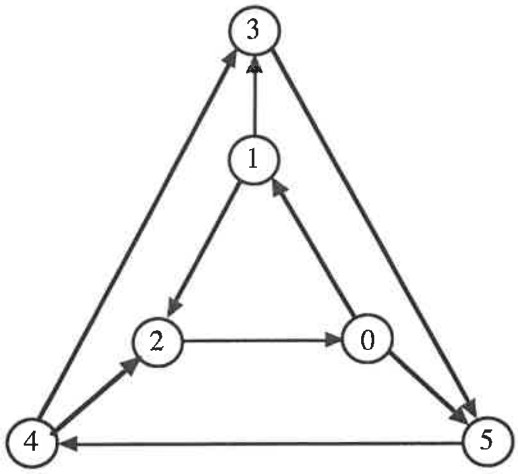
12. A topological ordering of a directed graph may be computed by:

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 Prim's algorithm implemented with a minheap is:

B A. θ(V + E)   B. θ(E log V)   C. θ(V log V)   D. θ(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:

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

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

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

18. The worst-case time for the memoryless version of Dijkstra's algorithm is:

C A. $\theta(V^2 + E)$ B. θ(E log V)   C. θ(EV)   D. $\theta(V^2 \log V)$

19. Suppose that there is only one path from vertex 7 to vertex 5 in a directed graph: 7 → 4 → 1 → 6 → 3 → 8 → 2 → 5. During the scan of which column will Warshall's algorithm record the presence of this path?

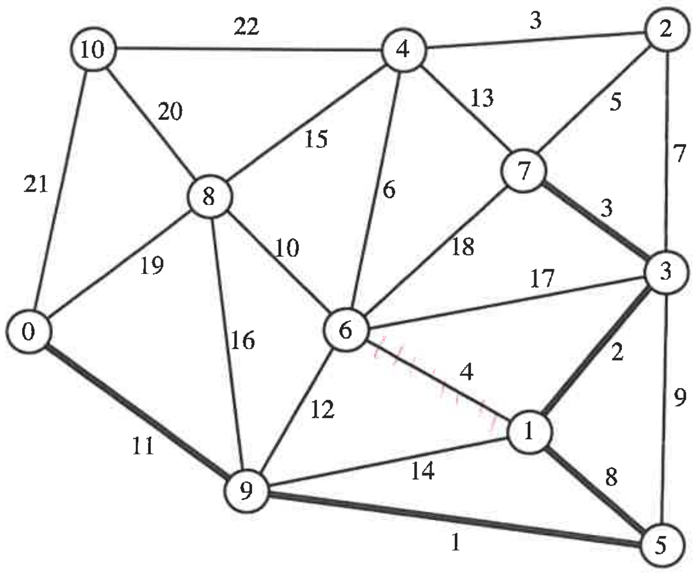
8

20. What is the expected number of probes for an unsuccessful search in hashing by chaining when there are 2000 items stored in a structure with 100 linked lists?

20   α = 20

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

2	5(7)
4	13(4)
6	4(1)
8	16(9)
10	21(0)

7

After

2	5(7)
4	6(6)
8	10(6)
10	21(0)

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

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)

17 × 7 = 119

117
17) 2001
17
30
17
131
119
12 = h_1

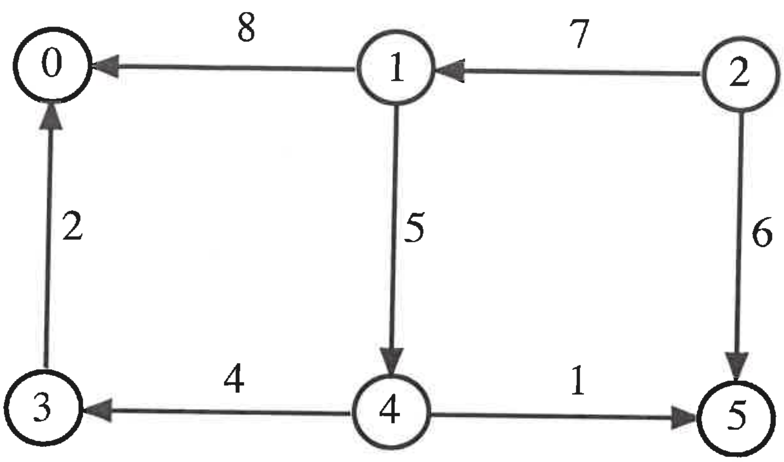
125
16) 2001
16
40
32
81
80
1+1=2 = h_2

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)

117
17) 2002
17
30
17
132
119
(13) = h_1

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



tailTab

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

headTab

0	0	8
1	4	5
2	1	7
3	5	6
4	0	2
5	3	4
6	5	1
7		

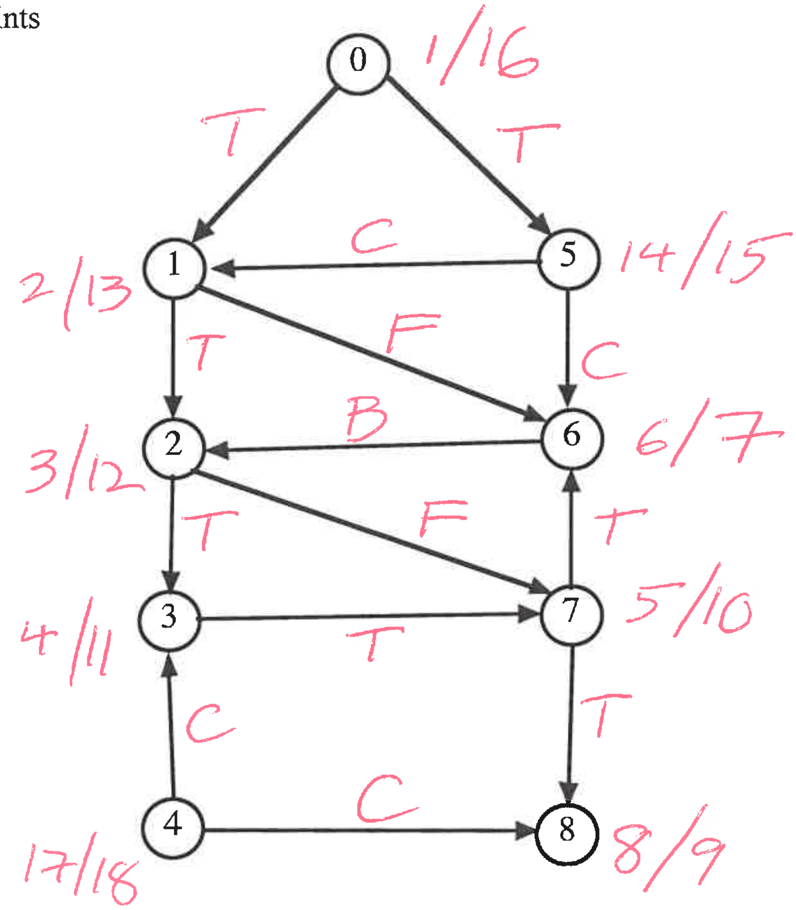
4. Code for the Floyd-Warshall algorithm appears below. Give code for a function `printPath()` that will print all vertices on a shortest path from vertex `start` to vertex `finish`. Be sure to print an error message if no path exists. The final `dist` and `succ` matrices from the Floyd-Warshall algorithm are available as global variables. (Error checking is not needed.) 10 points.

```
for (j=0;j<n;j++)
{
  for (i=0;i<n;i++)
    if (dist[i][j]<oo)
      for (k=0;k<n;k++)
        if (dist[j][k]<oo)
        {
          newDist=dist[i][j]+dist[j][k];
          if (newDist<dist[i][k])
          {
            dist[i][k]=newDist;
            succ[i][k]=succ[i][j];
          }
        }
}
```

```
void printPath(int start, int finish)
{   int i;
    if (dist[start][finish] == oo)
    {
      printf("No path
      return;
    }
    printf("%d\n", start);
    i=succ[start][finish];
    while (i!=finish)
    {
        printf("%d \n", i);
        i=succ[i][finish];
    }
    printf("%d \n", finish);

}
```

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

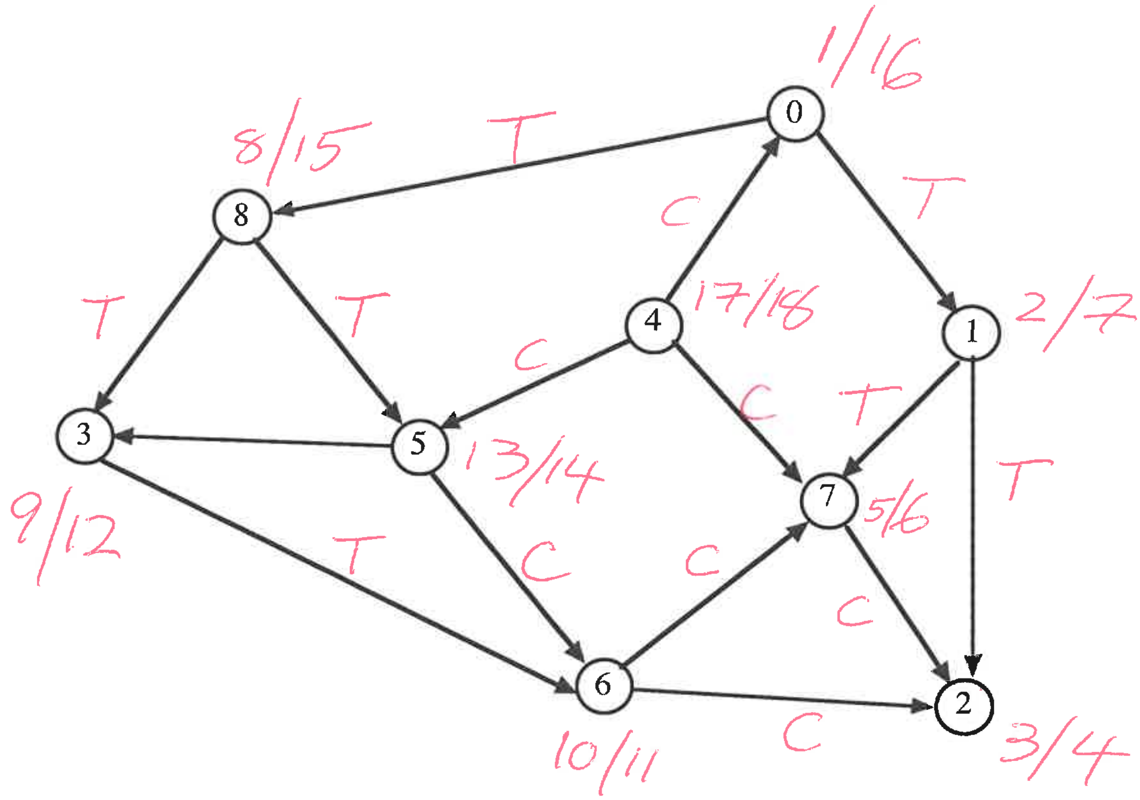


Vertex	Start	Finish	Edge	Type	Edge	Type
0	1	16	0 1	T	5 1	C
1	2	13	0 5	T	5 6	C
2	3	12	1 2	T	6 2	B
3	4	11	1 6	F	7 6	T
4	17	18	2 3	T	7 8	T
5	14	15	2 7	F		
6	6	7	3 7	T		
7	5	10	4 3	C		
8	8	9	4 8	C		

32 slots

2 errors = 1 point

6. Demonstrate, for the graph below, the algorithm that uses ***depth-first search*** to determine a topological ordering. Assume that the adjacency lists are ***ordered***. Show your work by labeling vertices with discovery and finish times. 10 points



Topological Ordering:

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