Seat: _____

I&C SCI 46 Diagnostic Exam 2, Spring 2022

DO NOT OPEN EXAM UNTIL INSTRUCTED TO DO SO

SILENCE MOBILE PHONE AND OTHER DEVICES

This is a diagnostic exam intended to help you evaluate your readiness for the real exam.

Write the following information **clearly**. You may write **this information only** before the instructor calls to begin the exam. You **may not** write this information after the instructor calls to stop writing.

Name : _____

UCI Email Address : _____@uci.edu

UCI Student ID # : _____

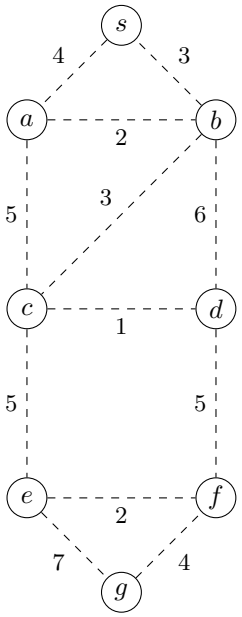
Read and understand the following rules; failure to abide by these rules, or directions given by course staff during the exam, may result in disciplinary action, including but not limited to a failing grade in the class.

- This exam is solely for students enrolled in this lecture. Anyone not enrolled in this lecture may not take an exam.
- Keep your UCI ID readily accessible during the test. Proctors may request to see it.
- This exam is closed book, closed notes, and is individual effort. Once course staff begin passing out exams, you may not communicate with anyone other than proctors for any reason, nor may you have electronics, including calculators watches and phones, available to you during the test for any reason. **YOU DO NOT NEED A CALCULATOR!**
- If you leave your seat during the test for any reason, your instructor may collect it and deem you to have turned it in. Do not ask proctors for an exemption to this, they are not authorized to grant such.
- If you are still seated at 9:35 AM at the real quiz, you may not leave your seat until explicitly dismissed by the instructor. Leaving after 9:35 AM and before being dismissed may result in a penalty.
- You must take the exam in your assigned seat unless the professor (not a TA) tells you otherwise. You may not open the exam until explicitly told to do so by the professor. The instructor will call to cease writing at 9:45 AM, at which point you must immediately cease writing and close the exam. You may not write any further at that point, including finishing one's current sentence.
- If you believe a question is ambiguous, write at least two reasonable interpretations and indicate clearly which one you will be using. Then answer your question with that assumption. Unless your interpretation makes the problem much more trivial than intended, we will grade your response as if one of us had made that clarification.
- The purpose of the real exam is to evaluate how well *you* understand the material presented in the course. It is an academic integrity violation to do anything that subverts the goals of this assessment including, but not limited to, not doing your own work or submitting that of anyone else.
- Write your answers in the space provided for each question.
- Write your UCI email at the top of each answer page. You may not do this until the exam has begun. There is one point for doing this.

Nothing you write on this page will be graded. The next page in this booklet contains a spot to answer these questions. You may use this page as scratch paper if you would like, and room to do so exists.

1. (a) (1 points) In the following graph, clearly fill in the edges that are in the single-source shortest path tree starting at s, such as one that would be output by Dijkstra's Algorithm. You do not need to show all of your work, but it is recommended that you keep your work reasonably well organized in the chart provided.

v	intree(v)	parent(v)	dist(v)
s		N/A	0
a			
b			
c			
d			
e			
f			
g			



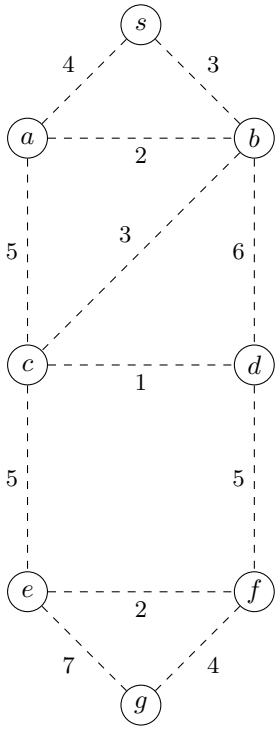
(b) (0.5 points) For the above graph, is the single-source shortest path tree rooted at s unique? Why or why not?

(c) (0.5 points) What is the shortest path from s to g?

2. (1.5 points) Let G be a simple, undirected graph with positive integer edge weights. Suppose we want to find the *maximum* spanning tree of G. That is, of all spanning trees of G, we want the one with the highest total edge weight. If there are multiple, any one of them is fine to find.

   Describe a simple algorithm to accomplish this.

1 (a) Fill in the edges for your answer:



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(b) For the above graph, is the single-source shortest path tree rooted at s unique? Why or why not?

(c) What is the shortest path from s to g?

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Write your answer for question 2 here.

Nothing you write on this page will be graded. The next page in this booklet contains a spot to answer these questions. You may use this page as scratch paper if you would like, and room to do so exists.

3. Suppose we have a Cuckoo Hash Table with each table having room for $m = 11$ entries each. Our hash functions are $h_0(x) = x\%11$ and $h_1(x) = (x/11)\%11$, where the / is integer division (floor of division; discard remainder). For example, $h_0(1289) = 2$ and $h_1(1289) = 7$. We insert the keys $12, 16, 27, 23, 31, 108, 103, 81$ and 48, in that order, into the table.

   For your convenience, here are the hash values:

x	12	16	27	23	31	108	103	81	48
$h_0(x)$	1	5	5	1	9	9	4	4	4
$h_1(x)$	1	1	2	2	2	9	9	7	4

   (a) (1 point) After the first six keys are inserted, are they in the upper array (indexed by h_0) or the lower array (indexed by h_1) after all of first six keys have been inserted? Circle your choice on each clearly.

   (b) (0.5 point) Give a value that is not currently in the table (after we have inserted every key listed above) but *cannot* be inserted into the table without a rehash or resize. You need only give the two hash values for your answer, not the element's value itself. You may not select a value that has h_0 and h_1 both equal to the same value in the set being inserted.

0	1	2	3	4	5	6	7	8	9	10

(0) (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

(0) (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

4. (1.5 points) Suppose we have a hash table of size $m = 13$, implemented with quadratic probing (defined here to mean that the ith choice is $(h(k) + i^2)\%m$, with the initial choice being $i = 0$) and with a hash function of $h(k) = k\%m$. The table stores unsigned values. Insert the following values into the hash table in the order they are given. Do not resize the hash table, regardless of load factor. The values to insert are: $38, 39, 26, 25, 16, 14, 22, 9$ (in the order listed).

0	1	2	3	4	5	6	7	8	9	10	11	12

Fill in your answer for question 3a here.

12	upper	lower
16	upper	lower
23	upper	lower
27	upper	lower
31	upper	lower
108	upper	lower

Write your answer for 3b in this box:

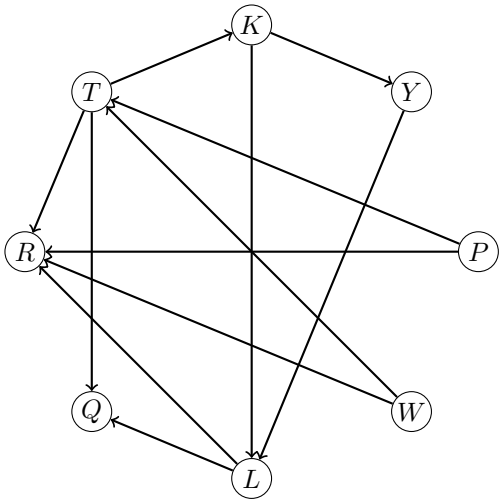
3b

Fill in your answer for question 4 here.

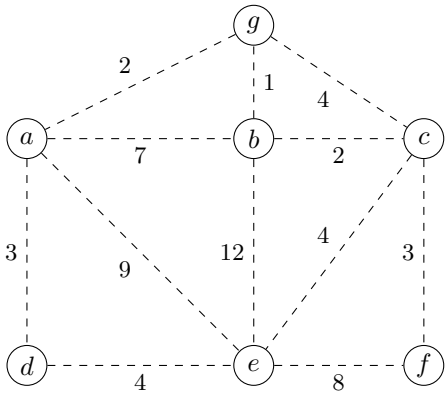
0	1	2	3	4	5	6	7	8	9	10	11	12

Nothing you write on this page will be graded. The next page in this booklet contains a spot to answer these questions. You may use this page as scratch paper if you would like, and room to do so exists.

5. (1 point) Give a valid topological ordering of the following graph. Write only the eight letters on the response page (no arrows, commas, etc).



6. (1 point) Find the minimum spanning tree of the following graph:



7. (2 points) Suppose you are given an unweighted directed graph $G = (V, E)$ which may or may not have cycles. The vertices, however, are all designated as either blue or gold. This may or may not be a valid 2-coloring of the graph (and, for this problem, it does not matter if it is). The *secluded factor* of any given vertex is the **larger** of the distance to reach it from the nearest gold vertex or the nearest blue vertex. If we cannot get to any particular vertex from both a gold and a blue vertex, then that vertex is *infinitely* secluded.

   Given such a graph, describe how you would find a vertex with the *smallest* secluded factor. Give and briefly justify the running time of your approach. For full credit, your approach should have linear running time. You may make any reasonable assumption about how the graph is represented that you would like; if it affects your algorithm, write the assumption in the answer space.

Write your answer for question 5 here.

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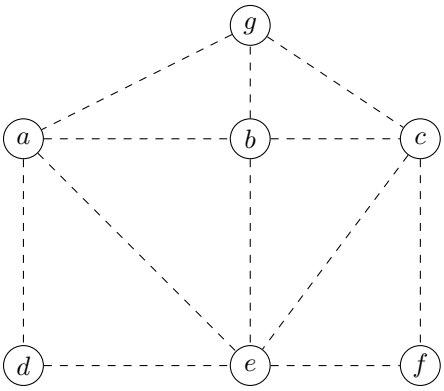
Write your answer for question 6 here.



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Write your answer for question 7 here.