General rules

1. This test is **open book**. You may consult the class notes, the recordings of the lectures, your programs, the textbook, and the Internet. You may not consult any person. You must cite any sources you consult.

Sources consulted:

2. You may use up to 2 hours for this exam (including any time you spend consulting sources). If you have a documented disability, you may spend additional time.

Reason for turning in after 12:30pm EDT Thursday, May 13:

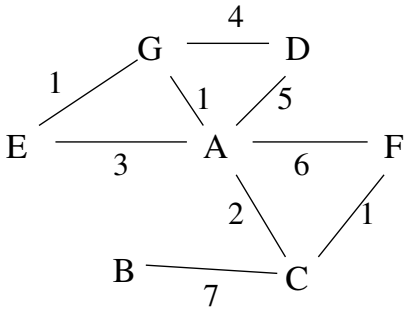
3. You must submit this exam via Canvas. You may (1) print the exam, write on it, then scan or photograph it, or (2) write the answers on paper and scan/photograph them, or (3) enter the answers into a computer file using Word or something similar, including pictures, and export the file as PDF. I prefer PDF, but JPEG is also acceptable. You may submit multiple pages either by multiple submissions or (preferably) as a single ZIP file.

4. You must sign this note (either scan this page or write it on your test:

I have not spoken with other people about this exam, and I will not speak with others who have not yet finished the exam. I have only used the allowed amount of time on the exam. Signature: _____

1 Graphs

These questions refer to this graph:



(a) Starting at vertex F, **list** the vertices that are visited in order by Depth-First Search (DFS). Always follow alphabetical order when there is a choice. Ignore the weights.

(b) Starting at vertex E, **list** the vertices that are visited in order by Breadth-First Search (BFS). Always follow alphabetical order when there is a choice. Ignore the weights.

(c) What is the **shortest weighted path** from vertex E to vertex B? _____

(d) Show the intermediate situation for Prim's algorithm, starting with vertex A, after 4 edges have been added. You may draw your answer on this skeleton:

G D

E A F

B C

(e) Show the intermediate situation for Kruskal's algorithm after 5 edges have been added. You may draw your answer on this skeleton:

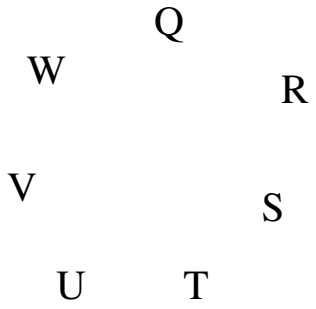
G D

E A F

B C

2 Union-find algorithm

(a) Consider vertices Q, R, S, T, U, V, W, initially disconnected. **Draw the directed graph** resulting from the following calls to `union()`. When you have a choice (you don't always have a choice), follow alphabetical order: earlier vertex points to later one. Do not use path compression. `union(Q,R),union(S,T),union(S,U),union(Q,U),union(V, W).`



(b) After all these union operations are finished, is the resulting graph *acyclic*? _____

(c) After all these union operations are finished, what is the **degree** of vertex T? _____

3 Numerical algorithms

(a) Show the steps in the Euclidean algorithm to find the greatest common divisor (gcd) of 381 and 141.

(b) Consider calculating 11^{23}. How many multiplications are needed for the brute-force calculation? _____

(c) How many multiplications are needed for the fast exponentiation algorithm? _____

(d) Draw a picture showing a BigNum representation of the number 895430243255237372246531 (that's actually 11^{23}) where every chunk is limited to numbers between 0 and 9999.

4 String matching

These questions refer to this text: *t*=`abcabcabcacd` and to this pattern: *p*=`bcac`.

(a) **Does** the search for *p* in *t* succeed? _____

(b) **How many** character-character comparisons does the brute-force search use? _____

(c) Assuming no hash collisions, **how many** character-character comparisons does the Rabin-Karp (hash-based pre-check) method use? _____

(d) **How many** character-character comparisons does the Boyer-Moore algorithm (searching from the end of *p* to its start) use, employing only the occurrence heuristic? _____

5 Edit distance

Complete this chart to compute the edit distance between the string `mystery` and the string `monster`. You don't need to show the path through the chart leading to the end.

		m	y	s	t	e	r	y
	0	1	2	3	4	5	6	7
m	1							
o	2							
n	3							
s	4							
t	5							
e	6							
r	7							