CS 2150 Final Exam, Fall 2018

Name _____

You MUST write your e-mail ID on **EACH** page and bubble in your userid at the bottom of this first page. And put your name on the top of this page, too.

If you are still writing when "pens down" is called, your exam will be ripped up and not graded – even if you are still writing to fill in the bubble form. So please do that first. Sorry to have to be strict on this!

Other than bubbling in your userid at the bottom of this page, please do not write in the footer section of this page.

There are 10 pages to this exam. Once the exam starts, please make sure you have all the pages. Questions are worth different amounts of points.

If you do not bubble in this first page properly, you will not receive credit for the exam!

Answers for the short-answer questions should not exceed about 20 words; if your answer is too long (say, more than 30 words), you will get a zero for that question!

This exam is CLOSED text book, closed-notes, closed-calculator, closed-cell phone, closed-computer, closed-neighbor, etc. Questions are worth different amounts, so be sure to look over all the questions and plan your time accordingly. Please sign the honor pledge below.

_____

_____

In theory, there is no difference between theory and practice.
But, in practice, there is.

Page 2: C++

1. [3 points] What are the three usages of the *const* keyword in C++? Explain what they do.

2. [3 points] List three problems that can occur with multiple inheritance. Specifically, problems that do not occur with single inheritance.

3. [3 points] Describe how dynamic dispatch is implemented in C++?

4. [3 points] List at least 5 *LLDB* or *GDB* commands that you have used to debug your codes this semester?

Page 3: Number Representation and big-Theta Analysis

5. [5 points] Represent -21.50 into IEEE 754 Floating Point Single Precision (32 bit), then express your answer in little-Endian hexadecimal notation. Show your work!

6. [4 points] If there was a 16-bit floating point standard with 1 sign bit, 4 exponent bits and 9 mantissa bits, what would the **maximum, finite** number be? You may leave the number as a formula.

7. [3 points] Why do we like big-Theta over big-Oh and big-Omega? What do we think of little-Theta?

Page 4: Trees and Hashes

8. [3 points] Describe a **realistic** scenario in which a hash table would result in a runtime slower than using a vector.

9. [3 points] What is the big-Theta run-time complexity (in the worst-case) of a hash table find method with quadratic probing as the collision resolution strategy? Explain your answer.

10. [3 points] What does it mean for a binary tree to be complete (or almost complete) and how did this help when implementing binary heaps?

11. [3 points] If you are given a word dictionary containing about 20000 words with none of them longer than 25 letters. Would the hash function $\mathbf{h}(s) = \sum_{i=0}^{k-1}(2s_i - i) \bmod \mathbf{tableSize}$ be good for this purpose? Explain why or why not.

Page 5: x86 Assembly

12. [3 points] List the steps necessary in the x86 C calling convention for callee's prologue.

13. [3 points] Given the initial state of the registers and the assembly snippet below, determine the final register values after the snippet is run. Assume that greatFunction() follows the calling convention. Answer with a question mark if unknown.

```
push rdi
push r11
call greatFunction
pop r11
pop rdi
```

Register	Initial State	After Snippet
rax	12	
rdi	2150	
r10	20	
r11	18	
rbx	19	
r14	100	
rsp	1819	

14. [6 points] Write an IBCM code snippet (i.e., just the relevant code, not an entire program) that will perform a *while* loop while variable B is greater than or equal to 5. Do not worry about the body of the *while* loop, we are interested in the loop control part, not the body. Your answer should be in IBCM opcodes; we dont want to be looking at hexadecimal notation. For any variable locations, you can ignore exactly where they are in memory, and just use the variable name.

Page 6: Graphs

15. [3 points] Do you agree with this statement: **All graphs are trees**? Explain your answer or give a counter example.

16. [3 points] What is the difference between a connected graph and a cyclic graph?

17. [3 points] In which scenario the adjacency matrix should be preferred over the adjacency list? Conversely, in which scenario the adjacency list should be preferred?

18. [3 points] What would the ideal algorithm for finding the degrees of separation between two people on a social media site such as Facebook? Explain your answer. For example, if Alice is friends with Bob who is friends with Jack, then Alice and Jack have 2 degrees of separation.

Page 7: More Graphs

19. [3 points] For a given connected, undirected graph $G = (V, E)$, let $G' = (V, E')$ be some spanning tree of G. How many edges are in G'? Write your result in terms of V.

20. [3 points] Explain which of the following has a faster asymptotic runtime: (1) Running a breadth-first search (implemented on a queue) on an unweighted graph G; (2) Running Dijkstra's algorithm (implemented on a priority queue) on the same graph G where all edge weights are 1.

21. [6 points] Perform the **Dijkstra's** shortest path algorithm on the following graph starting from node A. For your convenience, we have include a table for you to write. To update a distance/path, you must cross out the old one.
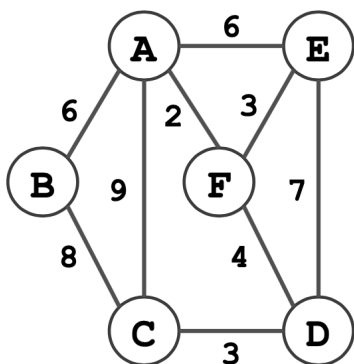
Vertex	Known?	Distance	Path
A			
B			
C			
D			
E			
F			

Page 8: Heaps and Huffman Coding

22. [3 points] What is the difference between lossy and lossless compression? Give 2 schemes of each.

23. [3 points] What is the time complexity of a generalized search for any value within a heap? Explain your answer.

24. [6 points] Consider the following frequency table extracted from a quote by Gandhi: **"where there is love there is life"**. Construct the Huffman coding tree based on this text, and determine the prefix codes. *You will likely need to use scrap paper (or space on **page 10**) to work on this problem, but your final answer **must** be shown below.*

Char	Freq	Prefix	#bits
e	8		
f	1		
h	3		
i	3		
l	2		
o	1		
r	3		
s	2		
t	2		
v	1		
w	1		
(space)	6		

Page 9: Demographics   Name & userid: _____

We meant to ask these in an end-of-the-semester survey, but we did not get to it in time. So we'll put it here for some extra points on the exam! Sorry if this page is a bit crowded...

25. [0 points] Did you put your name and userid at the top of this page? You need to do so in order to get the points on this page!

26. [2 points] What is your major or minor? If you have not declared, then answer with your intended major or minor. Please circle one.

    - BS CS
    - BS CpE
    - Other (please explain): _____
    - BA CS
    - CS minor
    - Neither majoring nor minoring in computing

27. [1 points] Have you already declared the major/minor mentioned above? Circle: Yes or No

28. [2 points] What CS 1 class did you take? Please circle one.

    - CS 1110
    - CS 1120
    - Other (please explain): _____
    - CS 1111
    - AP credit
    - Placed out of it via the CS 1110 placement exam
    - CS 1112
    - Transfer credit

29. [1 points] If you took your CS 1 class in college (i.e. CS 1110, CS 1111, CS 1112, CS 1120, or a transfer class), in what semester did you take it? Please specify a semester by season and calendar year (i.e., "fall 2014" and not "my second year").

30. [2 points] What CS 2 class did you take? Please circle one.

    - CS 2110
    - Other (please explain): _____
    - CS 2220
    - Transfer credit
    - AP credit
    - Placement exam

31. [1 points] If you took your CS 2 class in college (i.e. CS 2110, CS 2220, or a transfer class), in what semester did you take it? Please specify a semester by season and calendar year (i.e., "fall 2014" and not "my second year").

32. [1 points] Did you attend the final exam review session? You'll get full credit for this question, as long as you answer it honestly (we know most that were there, but not all).

33. [2 points] For the 3-credit courses for next semester (not summer or J-term):

    - How many CS courses are you enrolled in (not wait-listed)?

    - How many CS courses are you wait-listed for?

    - How many CS courses would you *like* to be enrolled in?

Page 10: No questions here

This page unintentionally left blank.

xkcd #683