

# CS 2150 Final Exam, fall 2019

**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 6 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.

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*Serious error.  
All shortcuts have disappeared.  
Screen. Mind. Both are blank.*

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**Page 2: Exam 1 material**

1. [3 points] *Briefly*, list 4 advantages of an array over a linked list.
2. [3 points] *Briefly*, why would we want to pass a pointer by reference? Give one example when this was discussed during class.
3. [3 points] *Briefly*, what is the difference between a dangling pointer and a memory leak?
4. [3 points] Consider the code snippet `int* a = new int(3);`. Match each expression below to a possible output. Note that more than one expression may have the same possible output and that not all possible outputs will have a matching expression. You can match by drawing lines, or by putting the letters (a) through (e), shown on the right, with their matching code segments on the left.

```
cout << a << endl;  
cout << &a << endl;  
cout << *a << endl;  
cout << a.value << endl;  
cout << a->value << endl;
```

```
a) Invalid expression, will not compile  
b) 3  
c) 0x7fa86b7000a0 (or similar address)  
d) Segmentation fault  
e) Will run but won't print anything
```

**Page 3: Exam 2 material**

5. [6 points] Write a *recursive* C/C++ function that determines if two binary trees are identical or not. Identical means that the two trees have the same structure and same values in each node. The prototype is: `bool isIdentical (Node* a, Node* b)`. A Node has `value`, `left`, and `right` fields.
6. [3 points] In x86 assembly, we want to compute  $y = 9x + 17$ . Assume that the value for  $x$  is in the register `rbx`, and that the result should go into register `rax`. How can you do this in as few statements as possible? Full credit for doing it only in one assembly statement, partial credit otherwise.
7. [3 points] Consider implementing a recursive subroutine in IBCM. *Briefly*, what would the activation record contain?

**Page 4: Heaps & Huffman**

8. [3 points] *Briefly*, what is the difference between a binary heap and a priority queue?

9. [6 points] Consider the following set of prefix codes and the encoded message: 100110101111001110. Construct the Huffman coding tree, and decode the message. You must show the resulting Huffman tree.

char	code
a	110
b	1111
d	10
e	0
f	1110

10. [3 points] For a binary heap of height 3, list all possible number of nodes in the heap. Note that a heap of just one node has height 0.



**Page 6: Miscellaneous**

15. [3 points] Given a `Rational` type, how would you allocate a new `Rational` via a pointer `r` in C (not C++!)?
  
  
  
  
  
  
  
  
  
  
16. [3 points] *Briefly*, what is the difference between shared and replicated multiple inheritance?
  
  
  
  
  
  
  
  
  
  
17. [3 points] *Briefly*, what does the `|` character do in the following command:  

```
./a.out | tail -1
```
  
  
  
  
  
  
  
  
  
  
18. [3 points] *Briefly*, list one thing that bash shell scripts are good for and one thing they are not good for.